United States
Department of
Agriculture

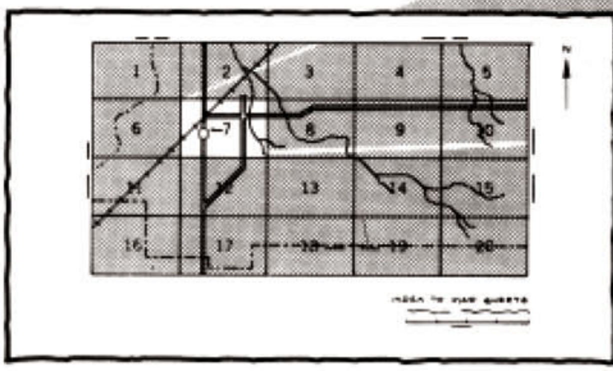
Soil
Conservation
Service

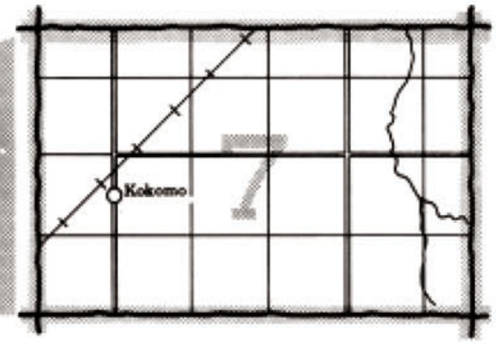
In Cooperation with
Texas
Agricultural
Experiment
Station

# Soil Survey of Comal and Hays Counties Texas

# HOW TO USE

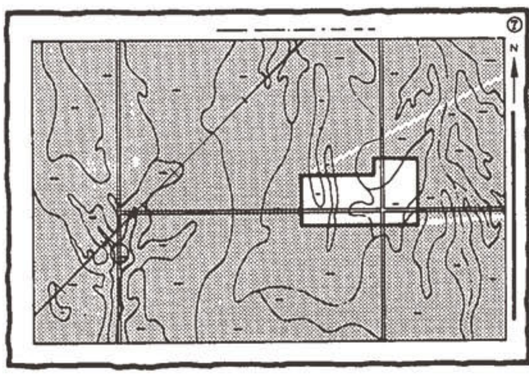
**1.** Locate your area of interest on the "Index to Map Sheets"

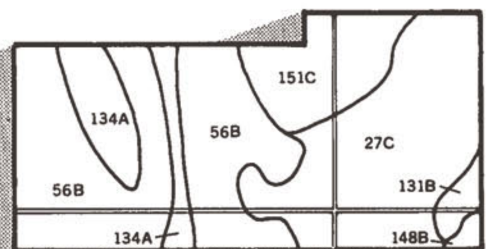


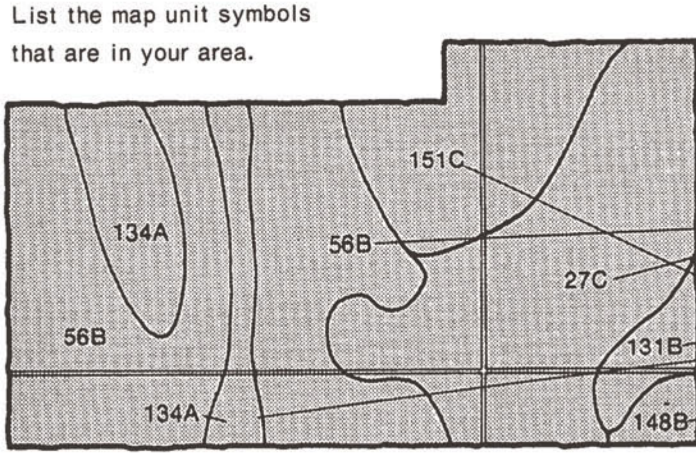

**2.** Note the number of the map sheet and turn to that sheet.

**3.** Locate your area of interest on the map sheet.






**4.** List the map unit symbols that are in your area.




**Symbols**

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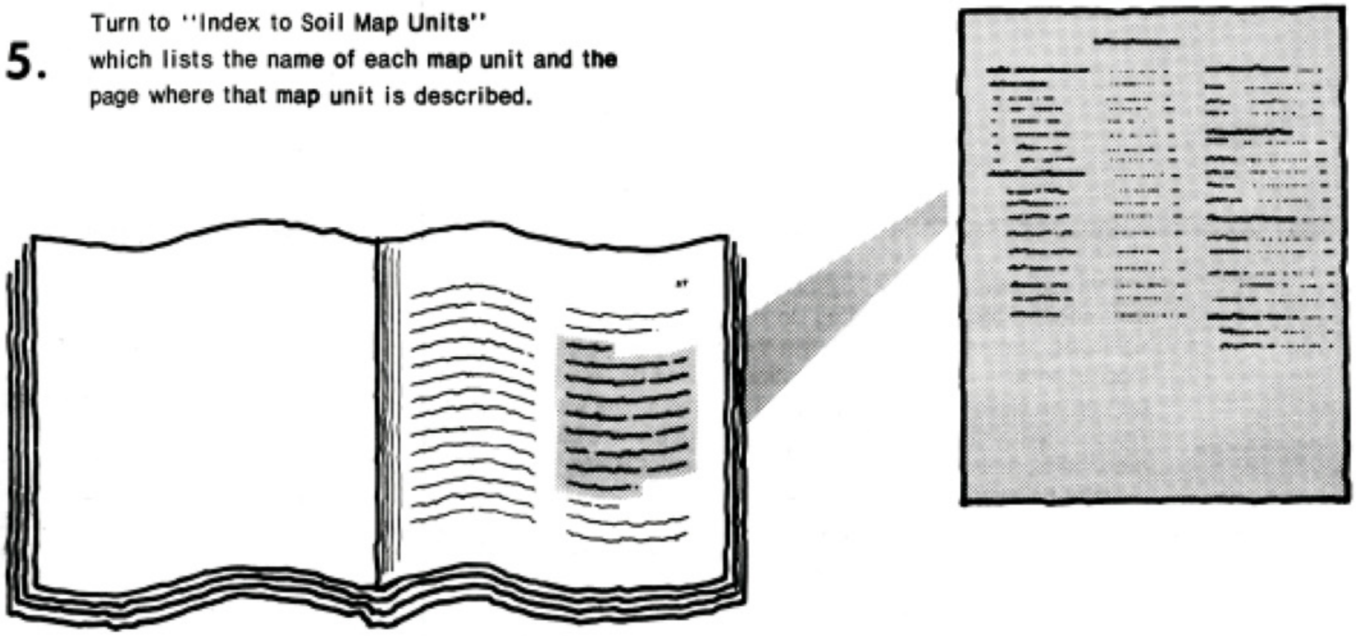
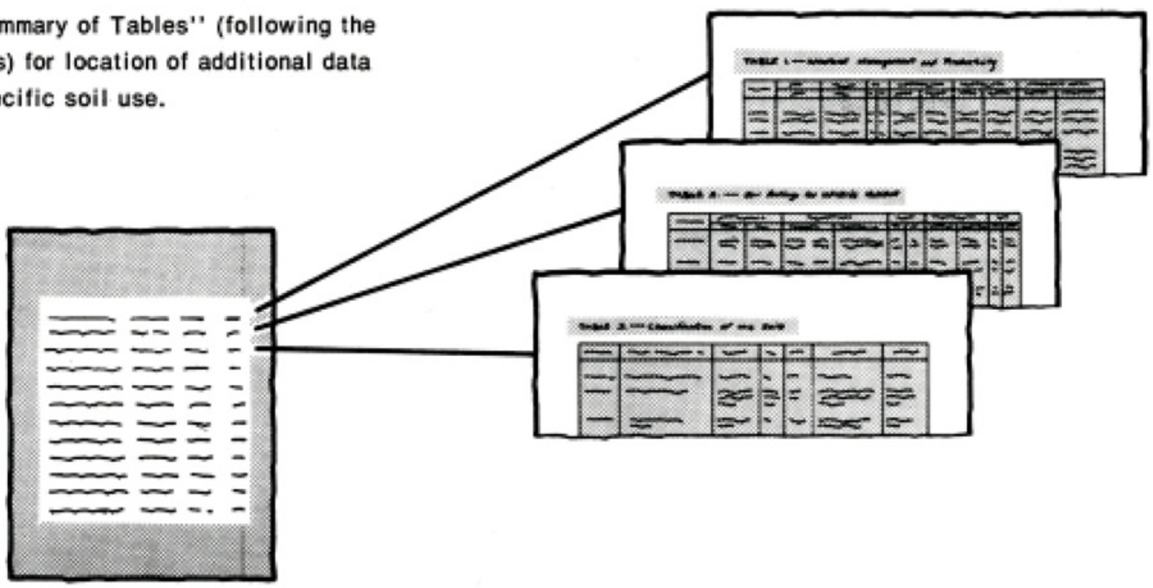
**56B**
**131B**
**134A**
**148B**
**151C**

# THIS SOIL SURVEY

**5.** Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



**6.** See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



**7.** Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1975-80. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Comal-Hays-Guadalupe Soil and Water Conservation District and the Hays-Caldwell-Travis Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

**Cover: An area of Rumple-Comfort association, undulating. The soil is Rumple very cherty clay loam. It produces medium yields of range forage.**

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# foreword

This soil survey contains information that can be used in land-planning programs in Comal and Hays Counties. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

George C. Marks

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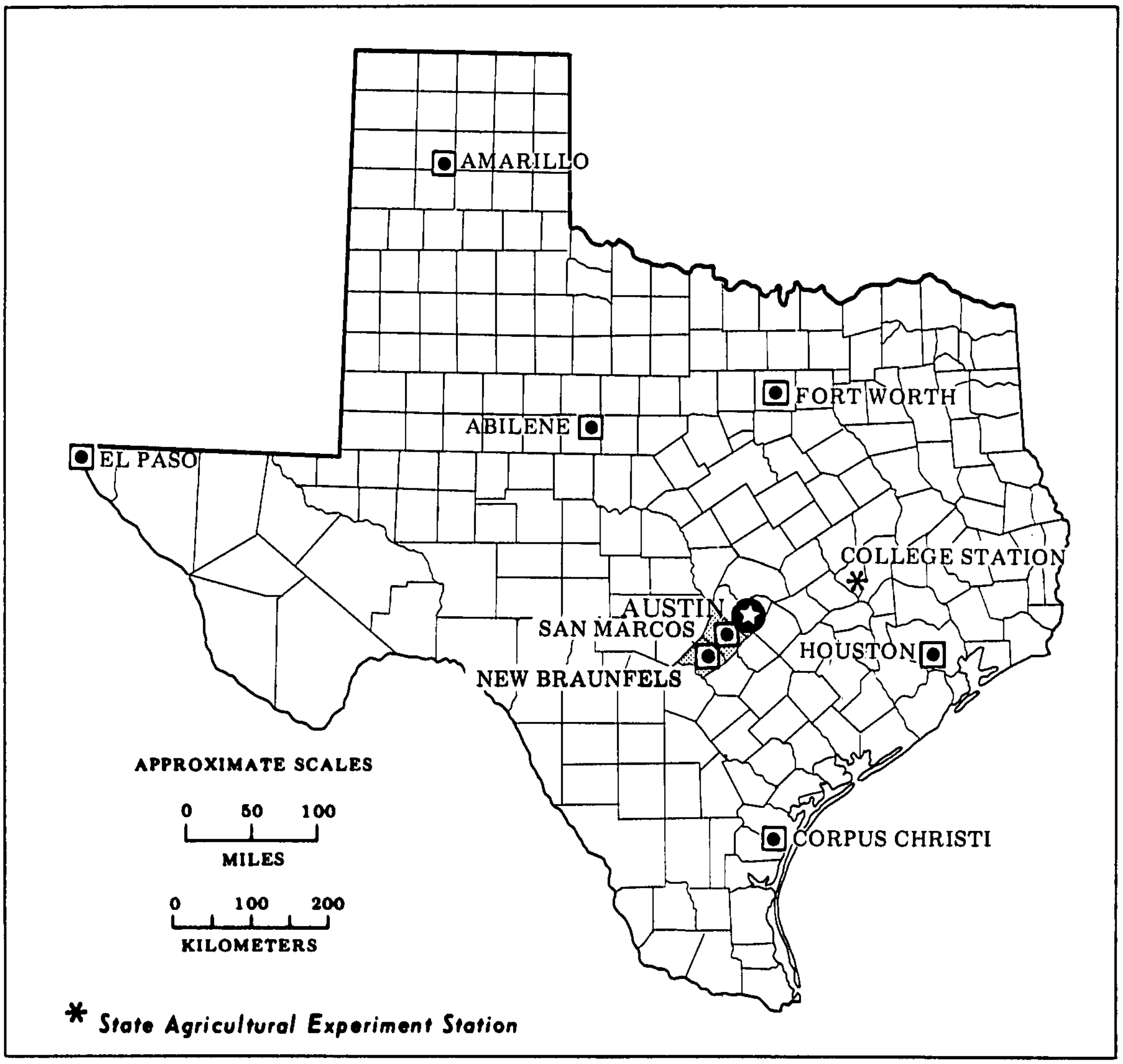


**Location of Comal and Hays Counties in Texas.**

# soil survey of
# Comal and Hays Counties Texas

By Charles D. Batte, Soil Conservation Service

Fieldwork by Charles D. Batte, Rosendo Trevino III, James Divin, and Eddie D. Bearden, Soil Conservation Service

Audrey C. Lowther and Robert N. Ramsey, Soil Conservation Service, assisted in field mapping

United States Department of Agriculture, Soil Conservation Service in cooperation with Texas Agricultural Experiment Station

COMAL AND HAYS COUNTIES are in south-central Texas. The two counties have a total area of 791,680 acres, or 1,237 square miles. Comal County has an area of 362,880 acres and Hays County, 428,800 acres. The survey area is bordered by Travis County on the north, Caldwell and Guadalupe Counties on the east, Bexar County on the south, and Kendall and Blanco Counties on the west.

In 1970, according to the U.S. Census, the population of Comal County was 24,195, and that of Hays County was 27,642. In 1980, the population of Comal County was 36,446. New Braunfels, the county seat, had a population of 17,859 in 1970 and a population of 22,402 in 1980. In 1980, the population of Hays County was 40,594. San Marcos, the county seat, had a population of 18,860 in 1970 and a population of 23,420 in 1980.

The Balcones Escarpment extends through the eastern part of both counties, separating the Edwards Plateau Land Resource Area and the Blackland Prairie Land Resource Area (fig. 1). Soils of the Edwards Plateau, locally known as the "Hill Country," are mostly shallow stony clays and gravelly clay loams. Soils of the Blackland Prairie are mainly deep clays. Elevation ranges from about 600 to 1,600 feet.

Land use in the survey area has undergone significant change since 1960. Some of the land once used for agriculture has been converted to urban uses. This conversion is due mainly to the expansion of the nearby urban areas of San Antonio and Austin. The growth of the smaller urban areas around New Braunfels and San Marcos and of retirement communities near Canyon Lake and Wimberley also has contributed to this change in land use.

Another significant change in land use has been the conversion of cropland, much of it marginal, to use as pasture. Since 1960 there has been a net loss of cropland and rangeland and a gain in urban land and land in pasture.

## general nature of the survey area

This section provides information of general interest about Comal and Hays Counties. It discusses briefly history, climate, natural resources, and agriculture.

### history

The area that is now Comal and Hays Counties was once occupied by nomadic Indians. Spanish explorers visited the area in the late 1600's and in 1691 blazed the Camino Real, or King's Highway. The road passed through the eastern part of the area that is now Comal and Hays Counties. It connected the Spanish missions in

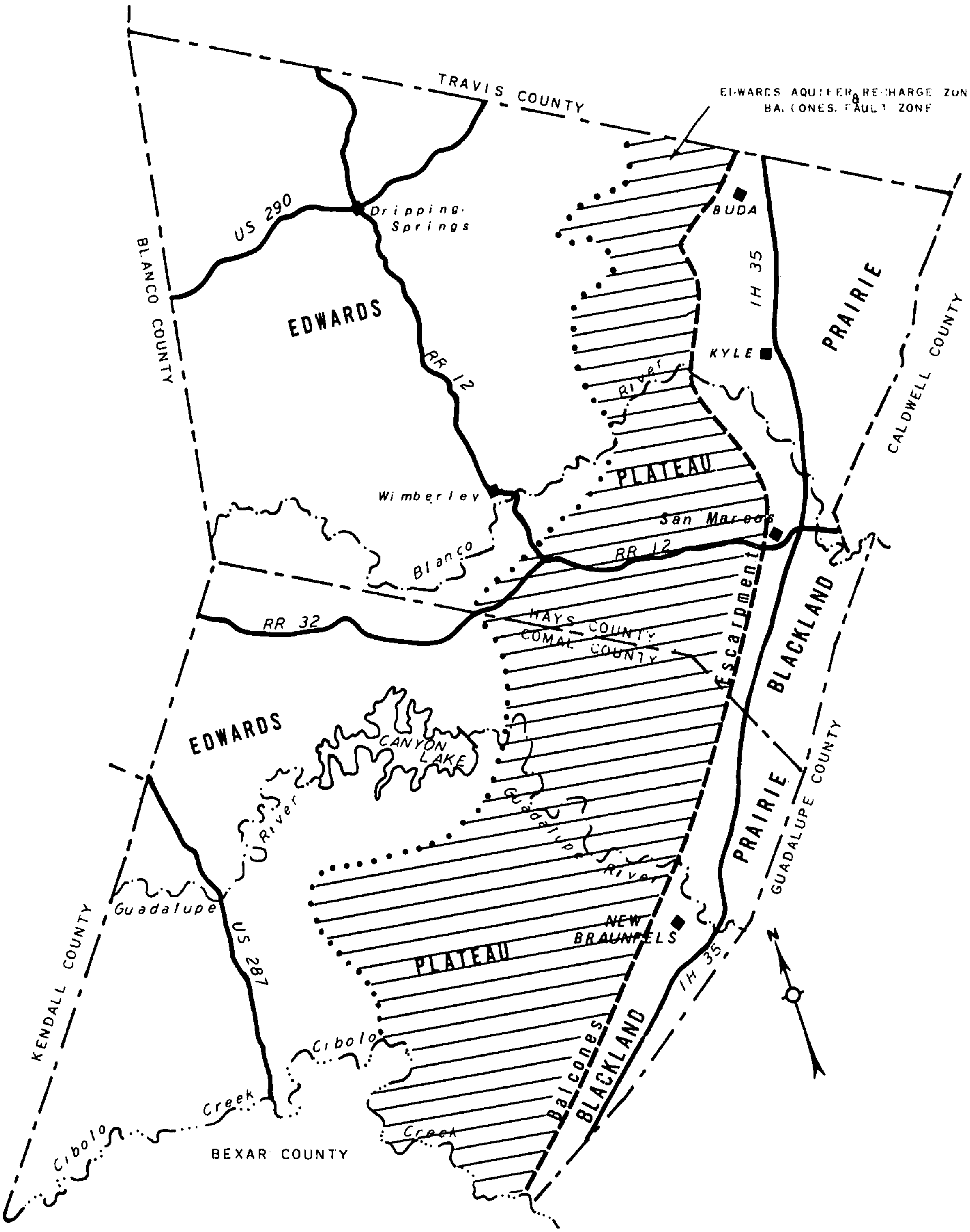


**Figure 1.—Land resource areas in Comal and Hays Counties.**

eastern Texas with settlements in Mexico. Spanish missions were built near San Marcos Springs and Comal Springs around the middle of the 1700's.

Comal County was organized in 1846 from Bexar, Gonzales, and Travis Counties. It was named for the Comal River.

Hays County was organized in 1848 from Travis County. It was named for John Coffee Hays, a famous Texas Ranger.

## natural resources

Soil is the most important resource in Comal and Hays Counties. It provides the base for a wide range of agricultural enterprises, including the production of livestock forage and of feed and fiber crops.

The soils in the Blackland Prairie Land Resource Area are well suited to improved pasture grasses. Many of these soils are well suited to field crops. Coastal bermudagrass, medio bluestem, King Ranch bluestem, and kleingrass are some of the most widely grown pasture grasses. Grain sorghum, cotton, corn, wheat, and oats are the most common crops. Some of the soils in this area are suitable for irrigation.

The soils in the Edwards Plateau Land Resource Area generally are best suited to use as rangeland. If proper management is practiced, most of these soils can provide good yields of high-quality forage for livestock.

Water is an important resource found in abundance in Comal and Hays Counties. The Edwards Aquifer (see figure 1) provides a steady supply of water of good quality for agricultural, municipal, industrial, and home use (*3, 4*). Part of the recharge zone for the aquifer is within the survey area. Two large springs and many small ones rise from the aquifer. Comal Springs in New Braunfels has an average flow of about 184 million gallons per day and is the source of the Comal River. San Marcos Springs in the city of San Marcos has an average flow of about 107 million gallons per day and is the source of the San Marcos River. These two rivers, as well as the Guadalupe and Blanco Rivers and Canyon Lake in Comal County, provide a multitude of recreation opportunities.

Wildlife, including deer, is abundant in the survey area. Several ranches have been stocked with exotic game animals.

Other natural resources include limestone, gravel, and caliche, which are excavated from open pit mines and are used mainly in road construction, as building material, and in the manufacture of cement.

## agriculture

The part of the survey area in the Edwards Plateau, or "Hill Country," is used mainly as rangeland, whereas the part in the Blackland Prairie is used mainly as cropland and pasture.

Ranches in the "Hill Country" are mostly beef cattle operations. Raising sheep and goats was a major enterprise at one time, but few are raised at present. There are small scattered areas of cropland. Oats and forage sorghums are the main crops. Hay is grown as a cash crop and for supplemental cattle feed during the winter.

In the Blackland Prairie, growing cultivated crops was once the primary agricultural enterprise. However, erosion on the more sloping soils, for example, map units AgC3, AgD3, AuC3, CaC3, DeC3, FeF4, HeC3, and HeD3, in the Altoga, Austin, Castephen, Denton, Ferris, and Heiden series, has caused a decrease in productivity. Most of these soils are now used as pasture or have been reestablished to native range. Raising beef cattle is the main livestock operation, although there are also a few dairy herds in the area. On the better soils, the main crops are grain sorghum, cotton, corn, oats, and wheat.

## climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Summers in Comal and Hays Counties are hot, and winters are fairly warm. Cold spells are of short duration, and snowfall is rare. Rainfall usually is heaviest late in spring and early in fall. In the fall, rain often is associated with a dissipating tropical storm. The total annual precipitation usually is adequate for range vegetation. Because of the high rate of evapotranspiration, however, it often is not adequate for optimum growth of cotton, small grains, and sorghum.

Table 1 gives data on temperature and precipitation for the survey area as recorded at New Braunfels in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 52 degrees F, and the average daily minimum temperature is 40 degrees. The lowest temperature on record, which occurred at New Braunfels on February 2, 1951, is 8 degrees. In summer the average temperature is 84 degrees, and the average daily maximum temperature is 96 degrees. The highest recorded temperature, which occurred on July 19, 1951, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 33 inches. Of this, 19 inches, or 57 percent, usually falls in April through September, which includes the growing season

for most crops. In 2 years out of 10, the rainfall in April through September is less than 14 inches. The heaviest 1-day rainfall during the period of record was 6.65 inches at New Braunfels on October 4, 1959. Unofficial records indicate that 16 inches of rain fell in a 4-hour period about 5 miles northwest of New Braunfels on May 11, 1972. Thunderstorms occur on about 40 days each year, and most occur in spring.

Snowfall is rare. In 90 percent of the winters, there is no measurable snowfall. In 10 percent, the snowfall, usually of short duration, is more than 2 inches. The heaviest 1-day snowfall on record was more than 3 inches.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southeast. Average windspeed is highest, 10 miles per hour, in spring.

## how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

A small part of Hays County was included in the Soil Survey of the San Marcos Area, which was published in 1906 (*5*). This soil survey of Hays County and Comal County gives additional information about the soils in the area and contains maps that show the soils in greater detail than those in the earlier survey.

# general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

## soil descriptions

### 1. Brackett-Comfort-Real

*Shallow, undulating to steep soils over limestone or strongly cemented chalk; on uplands of Edwards Plateau*

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 2). The soils are on hills, ridges, and valleys. They are underlain by alternating layers of chalk, marl, and cemented to indurated limestone. The limestone is more resistant to weathering and erosion than the marl. Consequently, limestone ledges give the hill slopes a benched or stepped appearance. This map unit accounts for about 49 percent of the survey area.

Brackett soils make up about 23 percent of the unit; Comfort soils make up 17 percent; Real soils make up 9 percent; and Bolar, Denton, Doss, Eckrant, Krum, Lewisville, Orif, Purves, Sunev, and Tarpley soils and Rock outcrop make up 51 percent.

The Brackett soils are undulating to steep. They are on hill slopes. Typically, the surface layer is grayish brown gravelly clay loam about 6 inches thick. The subsoil is light gray gravelly clay loam about 8 inches thick. The underlying material is weakly cemented limestone that has thin strata of calcareous shaly clay.

The Comfort soils are undulating. They are on ridge summits and short hill slopes near indurated limestone outcrops. Typically, the surface layer is dark brown extremely stony clay about 6 inches thick. The subsoil is dark reddish brown extremely stony clay about 7 inches thick. The underlying material is indurated, fractured limestone.

The Real soils are undulating to steep. They are on hill slopes. Typically, these soils are dark grayish brown to a depth of about 14 inches. The upper part is gravelly loam, the middle part is very gravelly loam, and the lower part is extremely stony loam. The underlying material is strongly cemented platy chalk.

The other soils in this map unit are the shallow, clayey Doss, Purves, and Tarpley soils on broad ridge summits and hillside benches; the shallow, strongly sloping to steep, stony and clayey Eckrant soils on hill slopes; the moderately deep, clayey Denton soils; the moderately deep, loamy Bolar soils; the deep, clayey Krum soils; the deep, loamy Sunev soils on foot slopes and toe slopes in valleys; the deep Lewisville soils on stream terraces; and the deep Orif soils on narrow flood plains.

The soils in this map unit are used mainly as rangeland. In a few areas they are used as pastureland and hayland. Many areas offer scenic views and are being converted to urban uses.

Forage yields on rangeland generally are medium because of the shallow rooting depth, the medium to rapid runoff, and the very low available water capacity.

The soils in this unit are not suited to use as cropland or pasture. They are suited to use as habitat for wildlife. They provide food and cover for deer, turkey, and quail.

Shallowness to rock, slope, and stoniness are limitations for urban and recreational uses.

### 2. Comfort-Rumple-Eckrant

*Very shallow to moderately deep, undulating to steep and hilly soils over indurated limestone; on uplands of Edwards Plateau*

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 3). The soils are on broad divides widely intersected by small drainageways. Sinks as much as 500 feet across are scattered over the landscape. There are areas of hilly and steep soils near the larger streams. This map unit accounts for about 31 percent of the survey area.

Comfort soils make up about 36 percent of the unit; Rumple soils make up 26 percent; Eckrant soils make up 8 percent; and Anhalt, Denton, Krum, Orif, Purves, Real,

Sunev, and Tarpley soils and Rock outcrop make up 30 percent.

The Comfort soils are undulating. They are on ridge summits and short hill slopes. Typically, the surface layer is dark brown extremely stony clay about 6 inches thick. The subsoil is dark reddish brown extremely stony clay about 7 inches thick. The underlying material is indurated, fractured limestone.

The Rumple soils are undulating. They are on broad interstream divides and short hill slopes. Typically, the surface layer is dark reddish brown very cherty clay loam about 10 inches thick. The subsoil is about 18 inches thick. To a depth of 14 inches it is dark reddish brown very cherty clay, and to a depth of 28 inches it is dark reddish brown extremely stony clay. The underlying material is indurated, fractured limestone.

The Eckrant soils are strongly sloping to steep. They are on side slopes of high ridges. Typically, the surface layer is very dark gray extremely stony clay about 10 inches thick. It is moderately alkaline. The underlying material is indurated, fractured limestone.

The other soils in this map unit are the shallow, clayey Tarpley and Purves soils on hillside benches and toe slopes; the shallow, loamy Real soils on low ridges intermingled with chalk outcrops; the moderately deep, clayey Anhalt and Denton soils; the deep, clayey Krum and Sunev soils on toe slopes in wide U-shaped valleys; and the deep Orif soils on narrow flood plains.

In most areas the soils in this map unit are used as rangeland. In a few areas they are used as pastureland and hayland. Many areas offer scenic views and are being converted to urban uses.

Forage yields on rangeland generally are medium.

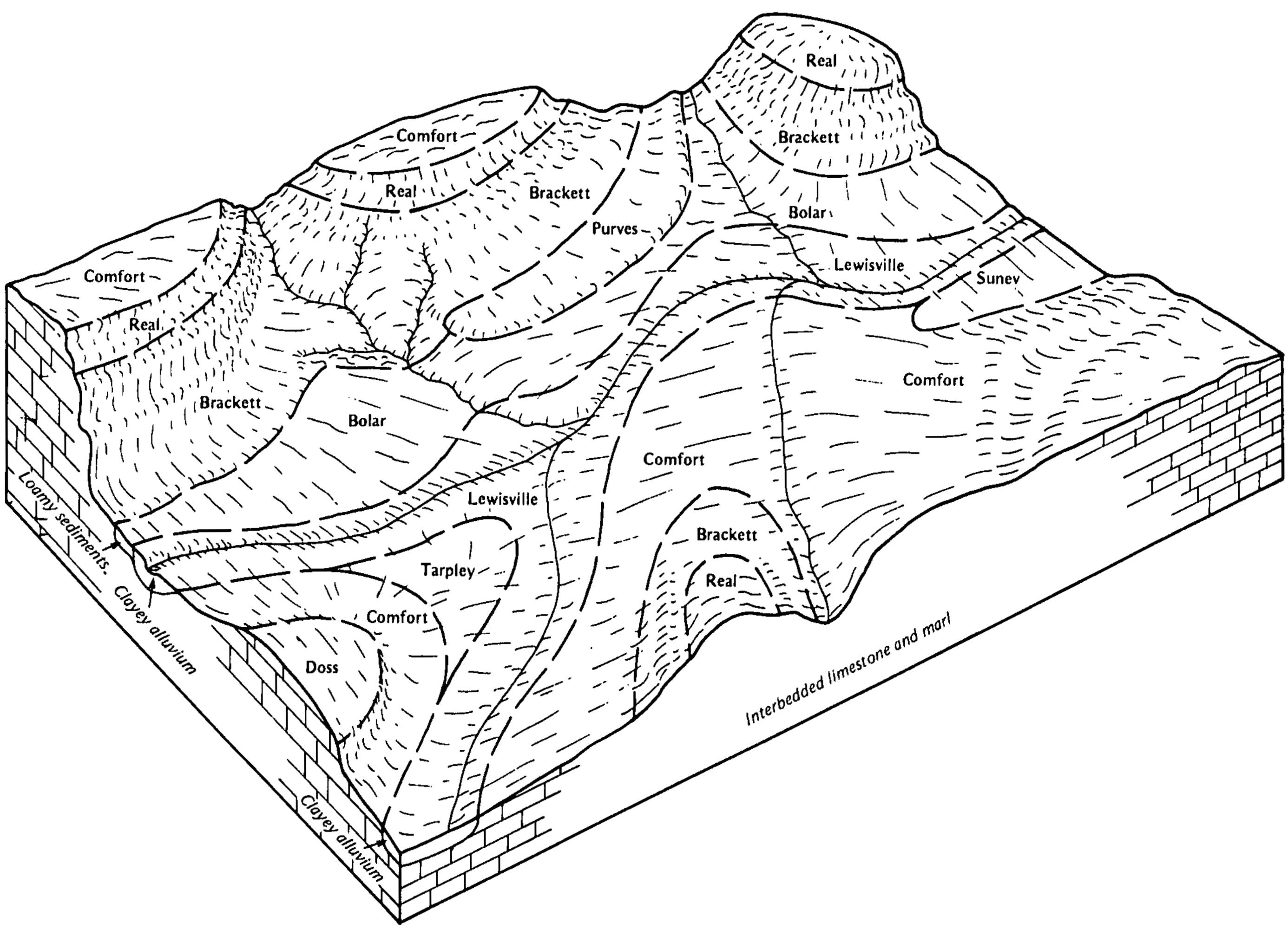


**Figure 2.—Pattern of soils in the Brackett-Comfort-Real general soil map unit.**

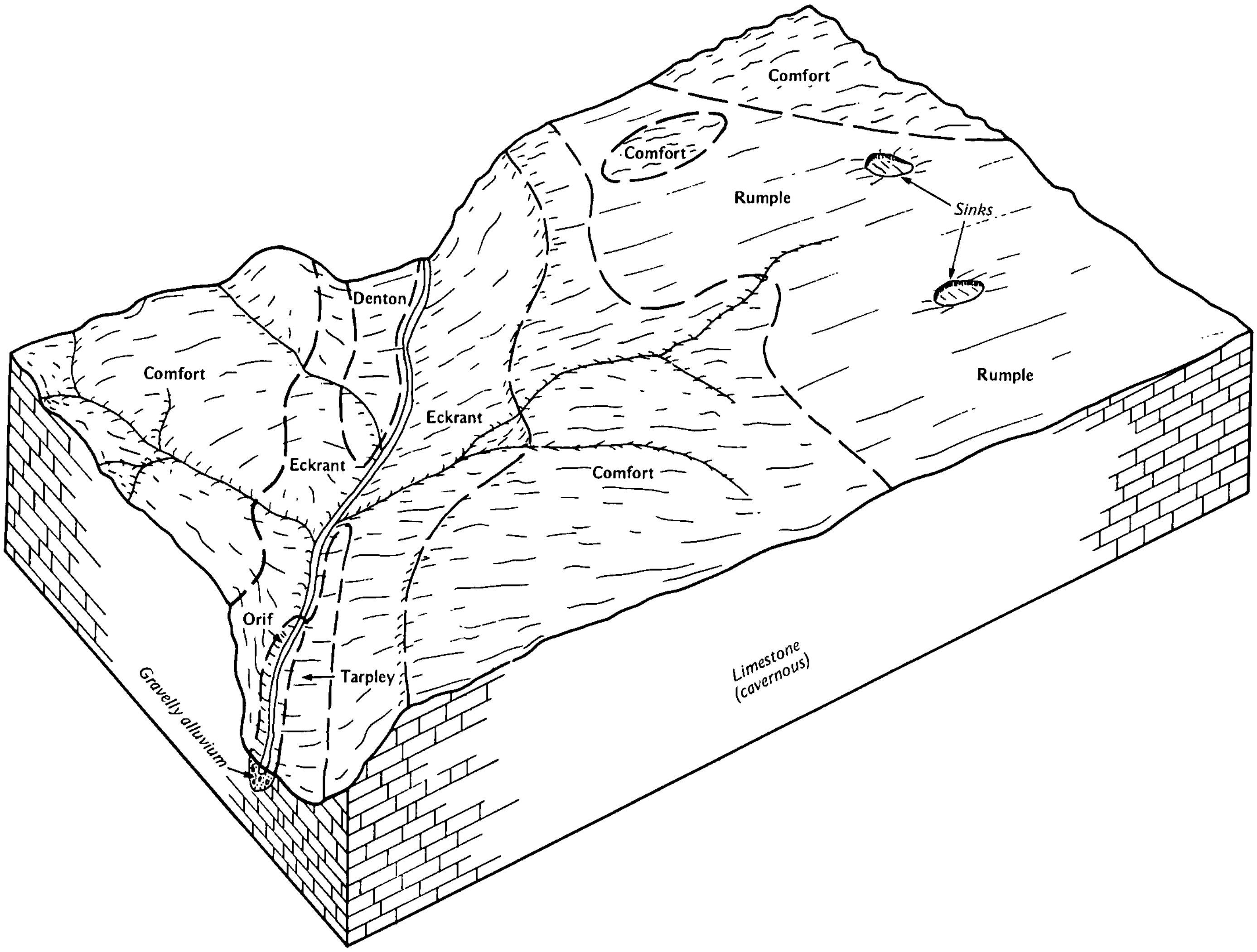


**Figure 3.—Pattern of soils in the Comfort-Rumple-Eckrant general soil map unit.**

The soils are not suited to crops or pasture, except in a few small areas where the soils are deeper. The shallow to very shallow rooting zone, the very low available water capacity, stoniness, and slope are limitations.

The soils provide habitat for deer, turkey, and quail.

Shallowness to rock, slope, and stoniness are limitations for urban and recreation uses.

### 3. Heiden-Houston Black

*Deep, gently sloping to sloping soils over clay and shale; on uplands of Blackland Prairie*

This map unit is made up dominantly of well drained and moderately well drained soils that have slopes of 1 to 8 percent (fig. 4). This map unit accounts for about 9 percent of the survey area.

Heiden soils make up about 42 percent of the map unit; Houston Black soils make up about 38 percent; and Altoga, Branyon, Ferris, and Tinn soils make up 20 percent.

The Heiden soils are gently sloping to sloping. They are mainly on the more eroded parts of the landscape. Typically, the surface layer is dark grayish brown clay about 13 inches thick. The layer below that, to a depth of 58 inches, is grayish brown clay. The underlying material is grayish brown shaly clay.

The Houston Black soils are gently sloping to sloping. They are on ridge summits and on long, smooth ridge slopes. Typically, the soil material is very dark gray clay

to a depth of about 50 inches. To a depth of 77 inches, it is grayish brown and gray clay. The underlying material is yellow marly clay.

The other soils in this map unit are the deep, clayey, highly calcareous Altoga soils on uplands; the deep, clayey Ferris soils on old eroded hill slopes; the deep, clayey Branyon soils on old stream terraces; and the deep, clayey Tinn soils on flood plains.

The soils in this map unit are used mainly for crops and pasture. Most areas of the more sloping soils on hillsides have been converted from cropland to pasture.

The soils are well suited to moderately well suited to row crops, including cotton and grain sorghum. The suitability depends on the slope and the hazard of erosion. The eroded and sloping Heiden soils are poorly suited to use as cropland. Erosion control is needed in most cropped areas.

The soils in this map unit are moderately well suited to well suited to use as pasture.

If the soils are used as rangeland, forage yields are high.

The soils provide suitable habitat for openland wildlife, including rabbit and small birds.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, include the high shrink-swell potential, corrosivity to uncoated steel, clayey texture, very slow permeability, and low strength, which affects roads and streets.

### 4. Lewisville-Gruene-Krum

*Deep, shallow, and very shallow, nearly level to gently sloping soils over loamy, clayey, and gravelly sediments; on stream terraces and valley fills of Blackland Prairie and Edwards Plateau*

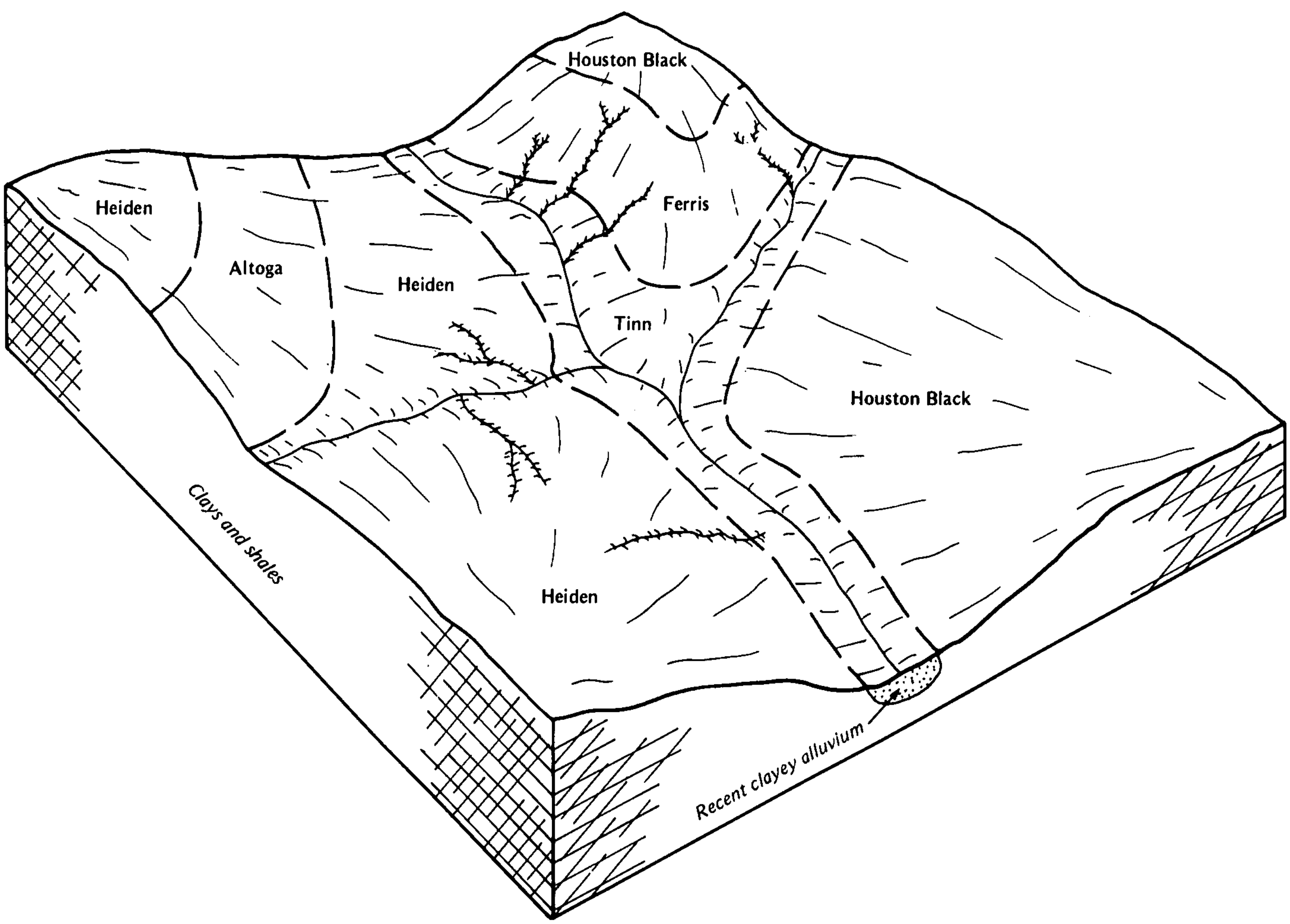


**Figure 4.—Pattern of soils in the Heiden-Houston Black general soil map unit.**

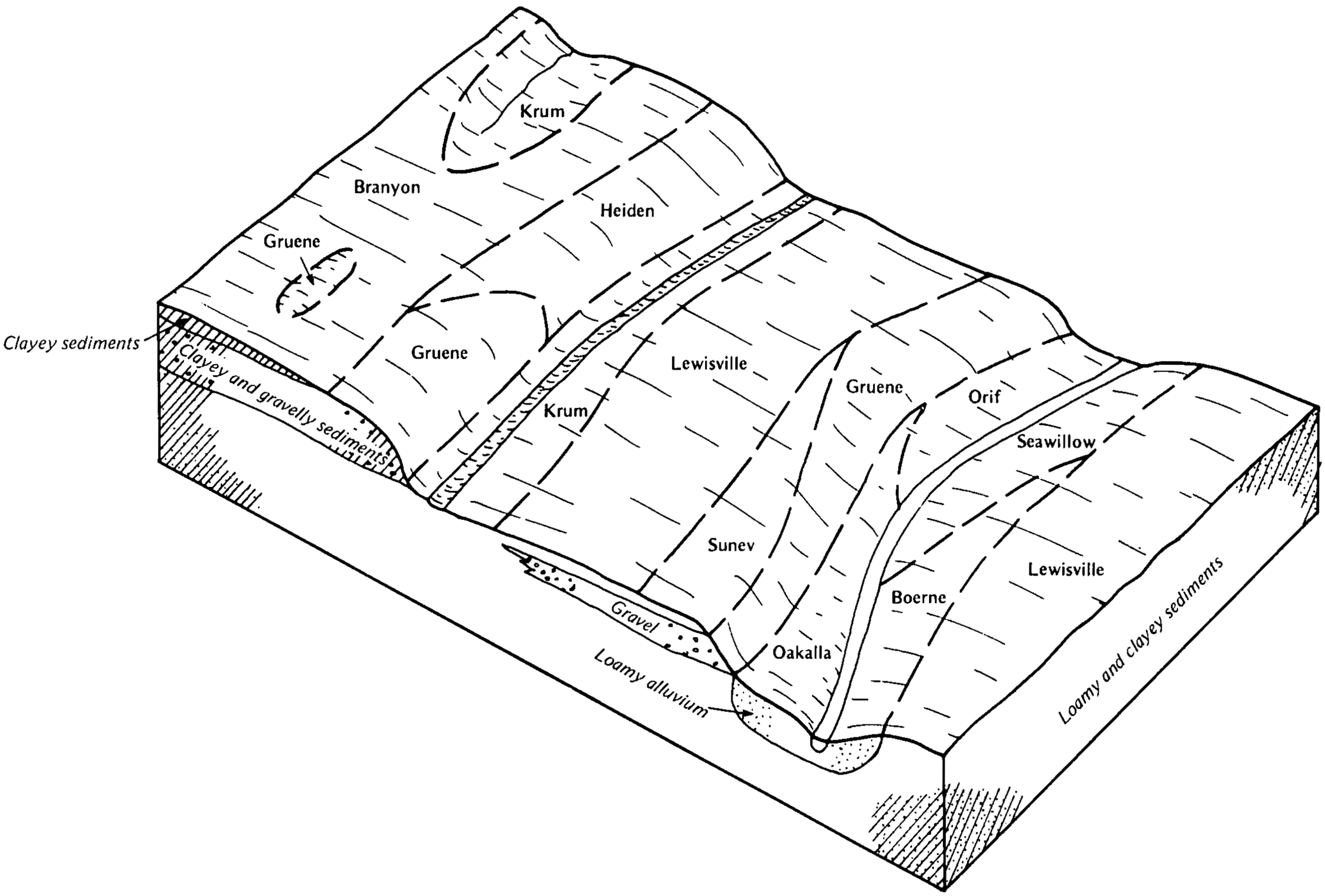


**Figure 5.—Pattern of soils in the Lewisville-Gruene-Krum and Branyon-Krum general soil map units.**

This map unit is made up dominantly of well drained soils that have slopes of 0 to 5 percent (fig. 5). The soils are on low terraces along rivers and large creeks. This map unit accounts for about 4 percent of the survey area.

Lewisville soils make up about 27 percent of the map unit; Gruene soils make up 14 percent; Krum soils make up 13 percent; and Boerne, Branyon, Oakalla, Orif, Seawillow, and Sunev soils and Pits make up 46 percent.

The Lewisville soils are nearly level to gently sloping. They are in plane to slightly convex areas that are slightly higher on the landscape than the areas of the Krum soils and lower than those of the Gruene soils. Lewisville soils are moderately permeable. Typically, the surface layer is dark grayish brown silty clay about 17 inches thick. The subsoil to a depth of 36 inches is brown silty clay, and to a depth of 54 inches it is yellowish brown silty clay. The underlying material is brown silty clay.

The Gruene soils are gently sloping. They are in convex areas that are slightly higher than the areas of Lewisville and Krum soils. Typically, the surface layer is very dark grayish brown clay about 13 inches thick. The layer below that is strongly cemented caliche. It extends to a depth of 22 inches. The underlying material is stratified very gravelly sand and very gravelly loam.

The Krum soils are nearly level to gently sloping. They are in slightly concave areas that are slightly lower in elevation than the areas of Lewisville and Gruene soils. Some of these areas are old stream channels that have been filled. Krum soils are moderately slowly permeable. Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil extends to a depth of 58 inches. It is grayish brown clay. The underlying material is brown clay.

The other soils in this unit are the deep, loamy Boerne, Seawillow, and Sunev soils in convex to plane areas on the lowest stream terraces; the deep, clayey Branyon soils in slightly concave areas; and the deep, loamy Oakalla soils and the deep, sandy and gravelly Orif soils on flood plains.

The soils in this map unit are used mainly for crops and pasture. Lewisville and Krum soils are well suited to these uses. Gruene soils are poorly suited because they are shallow to caliche. Irrigation is used in a few areas.

In a few areas the soils are used as rangeland. Forage yields are high on the Lewisville and Krum soils and medium on the Gruene soils.

The soils provide habitat for openland wildlife, including rabbit and small birds. Deer, turkey, and quail inhabit areas where they find cover and food.

There are limitations to use of the soils for urban development. The limitations, which are difficult to overcome, are clayey texture, shrink-swell potential, and low soil strength, which affects roads and streets. The soils are moderately well suited to recreation uses. Clayey texture is the most severe limitation.

### 5. Branyon-Krum

*Deep, nearly level to gently sloping soils over clayey sediments; on ancient stream terraces and valley fills of Blackland Prairie*

This map unit is made up dominantly of moderately well drained and well drained soils that have slopes of 0 to 5 percent (fig. 5). The soils are on ancient, high terraces along rivers and large creeks. The areas are broad and smooth and are widely dissected by small drainageways. This map unit accounts for about 3 percent of the survey area.

Branyon soils make up about 64 percent of the map unit, Krum soils make up 19 percent, and Heiden, Gruene, and Tinn soils make up 17 percent.

The Branyon soils are nearly level to gently sloping. They are mainly in broad, smooth areas. Typically, the soil material is dark gray clay to a depth of about 44 inches. To a depth of 60 inches it is grayish brown clay. The underlying material to a depth of 80 inches is very pale brown and pale yellow clay.

The Krum soils are nearly level to gently sloping. They are mainly in broad, smooth areas. Typically, the surface layer is dark gray clay about 14 inches thick. The subsoil extends to a depth of 58 inches. It is grayish brown clay. The underlying material is brown clay.

The other soils in this unit are the deep, clayey Heiden soils on hill slopes, the deep, clayey Tinn soils on narrow flood plains of small streams, and the shallow, clayey Gruene soils on convex uplands.

The soils in this map unit are used mainly as cropland. In a few areas they are used for improved pasture. The soils are well suited to crops and pasture. They are suitable for irrigation.

If the soils in this map unit are used as rangeland, forage yields are high.

The soils provide habitat for openland wildlife, including rabbit and small birds.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, are clayey texture, shrink-swell potential, very slow permeability, and low strength, which affects roads and streets.

### 6. Krum-Medlin-Eckrant

*Deep, very shallow, and shallow, undulating to steep and hilly soils over clay, shaly clay, and limestone; on stream terraces, valley fills, and uplands of Edwards Plateau*

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 6). The soils are on low hills and U-shaped valleys. This map unit accounts for about 2 percent of the survey area.

Krum soils make up about 30 percent of the map unit; Medlin soils make up 15 percent; Eckrant soils make up about 15 percent; and Bolar, Denton, Doss, Purves, Rumple, and Tarpley soils make up 40 percent.

The Krum soils are gently sloping. They are on foot slopes and toe slopes in U-shaped valleys. Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil to a depth of 58 inches is grayish brown clay. The underlying material to a depth of 66 inches is brown clay.

The Medlin soils are undulating to hilly. They are on the middle and lower hill slopes. Typically, the surface layer is grayish brown stony clay 6 inches thick. The layer below that, to a depth of 11 inches, is grayish brown clay, and to a depth of 50 inches it is light yellowish brown clay. The underlying material is light gray shaly clay.

The Eckrant soils are undulating to hilly. They are on the upper part of hill slopes. Typically, the soil material is very dark gray extremely stony clay about 10 inches thick. The underlying material is indurated, fractured limestone.

The other soils in this map unit are the shallow, clayey Doss, Purves, and Tarpley soils on hillside benches and toe slopes in valleys; the moderately deep, clayey Denton and Bolar soils on foot slopes and toe slopes; and the moderately deep, clayey Rumple soils on the summit of ridges.

Krum soils are used mainly for crops and pasture. The principal crops are oats and forage sorghums. These soils are well suited to crops and pasture. Yields are high if good management is practiced.

The Medlin and Eckrant soils are used mainly as rangeland. Yields of range forage are medium. These soils are not suited to crops or pasture mainly because of the shallow rooting zone, slope, the very low available water capacity, and stoniness.

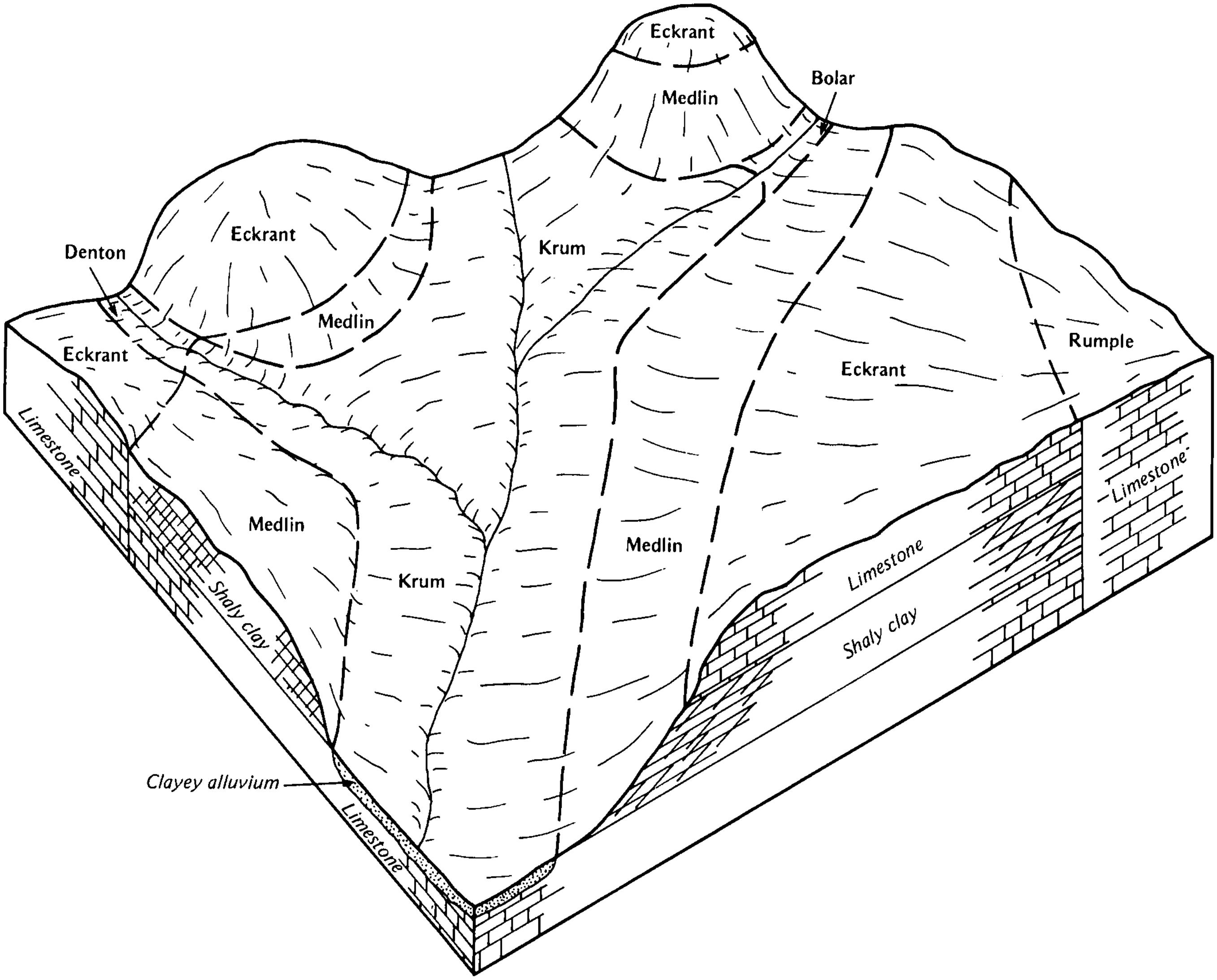


**Figure 6.—Pattern of soils in the Krum-Medlin-Eckrant general soil map unit.**

The soils in this map unit provide habitat for deer, turkey, dove, and quail.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, are shallowness to rock, slope, stoniness, shrink-swell potential, and clayey texture.

## 7. Austin-Castephen-Houston Black

*Shallow to deep, gently sloping to sloping soils over chalk or marly clay; on uplands of Blackland Prairie*

This map unit is made up dominantly of well drained and moderately well drained soils that have slopes of 1 to 8 percent. It accounts for about 1 percent of the survey area.

Austin soils make up about 21 percent of the unit; Castephen soils make up 20 percent; Houston Black soils make up 18 percent; and Heiden, Real, and Tinn soils make up 41 percent.

Austin soils are gently sloping. Typically, the surface layer is dark grayish brown silty clay about 11 inches thick. The subsoil, to a depth of 24 inches, is brown and pale brown silty clay. The underlying material is white, weakly cemented platy chalk.

Castephen soils are gently sloping. Typically, the surface layer to a depth of 8 inches is dark grayish brown clay loam, and to a depth of 16 inches it is dark brown clay loam. The underlying material is white, weakly cemented, platy chalk.

Houston Black soils are gently sloping. They are in plane to slightly concave areas near small drainageways. The positions are lower on the landscape than those of Austin and Castephen soils. Typically, the soil material is very dark gray clay to a depth of about 50 inches. To a depth of 77 inches, it is grayish brown clay. The underlying material is yellow marly clay.

The other soils in this map unit are the deep, clayey Heiden soils on convex uplands; the deep, clayey Tinn soils on flood plains of small creeks; and the shallow, loamy Real soils on ridges and hill slopes.

The soils in this map unit are used mainly as rangeland and pastureland. In a few areas they are used for row crops and hay.

Most of the soils are well suited to pasture. Forage yields are high.

The Austin and Houston Black soils are well suited to crops, and the Castephen soils are poorly suited because of a shallow rooting zone.

The soils in this map unit provide habitat for openland wildlife, including rabbit and small birds.

The Austin and Houston Black soils have several limitations for urban and recreation uses, including high shrink-swell potential, very slow permeability, clayey texture, and low strength, which affects roads and streets. These limitations are difficult to overcome. On the Castephen soils, shallowness to rock and the clayey texture are limitations for urban and recreation uses.

# detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Heiden clay, 1 to 3 percent slopes, is one of several phases in the Heiden series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Austin-Castephen complex, 1 to 3 percent slopes, is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Rumple-Comfort association, undulating, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Oakalla soils, frequently flooded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Some of the boundaries on the soil maps of Comal and Hays Counties do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

## soil descriptions

**AgC3—Altoga silty clay, 2 to 5 percent slopes, eroded.** This is a deep, gently sloping soil on convex, smooth slopes of low hills. The areas are irregular in shape and range from 5 to 150 acres in size. Sheet and rill erosion have removed 25 to 50 percent of the surface layer. Small gullies less than 3 feet deep and generally

500 to 1,000 feet apart are scattered throughout the areas.

Typically, the surface layer is grayish brown, moderately alkaline silty clay about 7 inches thick. The upper part of the subsoil extends to a depth of 13 inches. It is light brownish gray, moderately alkaline silty clay. The lower part of the subsoil extends to a depth of 36 inches. It is light gray, moderately alkaline silty clay that has a few soft masses and rounded concretions of calcium carbonate. It is about 55 percent calcium carbonate (lime). The next layer, to a depth of 60 inches, is white, moderately alkaline silty clay.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard. Fertility has been reduced because of erosion.

Included with this soil in mapping are small areas of Heiden and Ferris soils and areas of less sloping Altoga soils that are not eroded or are only slightly eroded. The included soils make up less than 15 percent of a mapped area.

This soil was once used mainly for row crops. However, it is now used mainly for pasture or hay. Grain sorghum, forage sorghums, and small grains are the main crops. King Ranch bluestem and Coastal bermudagrass are the main pasture grasses.

This soil is moderately well suited to use as cropland. Medium yields can be obtained under good management. Fertilization and proper residue management improve tilth and fertility and help prevent erosion. Contour farming and terraces are needed to control runoff. In some places, grassed waterways are needed to carry off excess water from terraces. Lime-induced chlorosis is a problem on this soil, especially for sorghum crops.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Altoga soil is well suited to use as pastureland. Improved bermudagrass, kleingrass, medio bluestem, and King Ranch bluestem grow well on this soil. Good management includes proper stocking, controlled grazing, and brush management. Gullies need shaping, smoothing, and revegetating.

This soil provides habitat for quail, dove, rabbit, small birds, and other openland wildlife.

Clayey texture, shrink-swell potential, corrosivity to uncoated steel, and low strength, which affects roads and streets, are limitations for urban uses. Slope is the main limitation for recreation uses.

This soil is in capability subclass IIIe and in the Clay Loam range site.

**AgD3—Altoga silty clay, 5 to 8 percent slopes, eroded.** This is a deep, sloping soil on convex, smooth hill slopes. The areas are irregular in shape and range from 5 to 450 acres in size. Sheet and rill erosion have removed 25 to 50 percent of the surface layer. Gullies less than 3 feet deep and generally 500 to 800 feet apart are scattered throughout the areas.

Typically, the surface layer is grayish brown, moderately alkaline silty clay about 12 inches thick. The upper part of the subsoil extends to a depth of 27 inches. It is light yellowish brown, moderately alkaline silty clay. The lower part of the subsoil extends to a depth of 42 inches. It is pale yellow, moderately alkaline silty clay that has a few soft masses of calcium carbonate. It is about 55 percent calcium carbonate (lime). The underlying layer, to a depth of 60 inches, is pale yellow, moderately alkaline shaly clay.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a severe hazard. Fertility has been reduced because of erosion.

Included with this soil in mapping are small areas of Heiden and Ferris soils and a soil similar to this Altoga soil that has a dark gray surface layer. The included soils make up less than 15 percent of a mapped area.

In many areas, this soil was once used for row crops. In most areas it is now used for pasture or hay. Forage sorghums are the main crops. King Ranch bluestem and Coastal bermudagrass are the main pasture grasses. In a few areas this soil is used as rangeland.

This soil is not suited to use as cropland. Fertility is low, and continuous vegetative cover is needed to adequately protect the soil from erosion.

This soil is well suited to use as pastureland. Improved bermudagrass, kleingrass, medio bluestem, and King Ranch bluestem grow well. Good management includes proper stocking and controlled grazing. Gullies need shaping, smoothing, and revegetating.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the main limitations are the clayey texture, shrink-swell potential, low strength affecting roads and streets, corrosivity to uncoated steel, and slope. These limitations can be overcome through good design and careful installation. Slope is the main limitation for recreation uses.

This soil is in capability subclass VIe and in the Clay Loam range site.

**AnA—Anhalt clay, 0 to 1 percent slopes.** This is a moderately deep, nearly level soil on plane to slightly concave slopes on uplands. It is generally near streams. The areas are irregular in shape and range from 10 to 250 acres in size.

Typically, the surface layer is dark brown, mildly alkaline clay about 18 inches thick. The layer below that extends to a depth of 28 inches and is dark reddish

brown, mildly alkaline clay. Below that, there is fractured, hard limestone.

This soil is well drained. In most areas it is not flooded. However, in a few areas adjacent to stream channels it is subject to rare flooding for brief periods. Surface runoff is slow. The available water capacity is low. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when the soil is wet. The rooting zone is moderately deep. However, the high content of clay tends to impede root penetration. If the soil is cultivated, good tilth is difficult to maintain because the clay causes the soil to be sticky when wet and very hard and cloddy when dry. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Tarpley and Denton soils, a few small areas of soils similar to the Anhalt soil except that they are deeper than 40 inches to bedrock, and a few areas of another soil that is similar to this Anhalt soil except that it is dark gray throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. Small grains and forage sorghums are the main crops. In some areas this soil is used as rangeland or for improved pasture.

This soil is moderately well suited to use as cropland. Very slow permeability and the low available water capacity are the main limitations. These conditions can be improved, and good tilth and fertility can be maintained if proper residue management is practiced.

This Anhalt soil is well suited to use as improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. This soil produces high yields of native range grasses in favorable years. Good management includes proper stocking, controlled grazing, and brush management.

This soil provides good habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome and can require expensive construction measures. The very slow permeability and clayey texture are limitations for recreation uses.

This soil is in capability subclass IIs and in the Deep Redland range site.

**AnB—Anhalt clay, 1 to 3 percent slopes.** This is a moderately deep, gently sloping soil on slightly concave foot slopes on uplands. It is generally near streams. The areas are irregular in shape and range from 10 to 150 acres in size.

Typically, the surface layer is dark reddish gray, neutral clay about 23 inches thick. The subsoil extends to a depth of 32 inches and is dark reddish brown, neutral clay. Below the subsoil there is fractured, indurated limestone.

This soil is well drained. Surface runoff is medium. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when the soil is wet. The available water capacity is low. The rooting zone is moderately deep. However, the clay tends to impede root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Tarpley and Denton soils. Also included are a few small areas of soils that are similar to this Anhalt soil except that one is deeper than 40 inches to bedrock and the other is dark gray throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. Small grains and forage sorghums are the main crops. In some areas this soil is used as rangeland or for improved pasture.

This soil is moderately well suited to use as cropland. The very slow permeability and the low available water capacity are the main limitations. These conditions can be improved, however, and good tilth and fertility can be maintained if proper residue management is practiced. Contour farming and terraces generally are needed to help control erosion.

This Anhalt soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome and can require expensive construction measures. The very slow permeability, clayey texture, and slope, in some places, are limitations for recreation uses.

This soil is in capability subclass IIIe and in the Deep Redland range site.

**AuB—Austin-Castephen complex, 1 to 3 percent slopes.** This complex consists of the moderately deep, clayey Austin soil and the shallow, loamy Castephen soil. These soils are gently sloping and are on uplands in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are irregular in shape and range from 10 to 300 acres in size.

Austin silty clay makes up 40 to 85 percent of the complex, but on the average it makes up 60 percent. Castephen silty clay loam makes up 10 to 45 percent, but the average is 30 percent. Other soils make up less than 5 percent to 30 percent, but the average is 10 percent. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Austin soil is dark grayish brown silty clay about 11 inches thick. The subsoil to a depth of 18 inches is brown silty clay, and to a depth of 24 inches it is pale brown silty clay loam and

has common concretions of calcium carbonate. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Austin soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is medium. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Typically, the surface layer of the Castephen soil is dark grayish brown silty clay loam about 15 inches thick. It is about 20 percent chalk pebbles. The layer below the surface layer extends to a depth of 18 inches. It is brown silty clay loam and about 50 percent chalk fragments. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Castephen soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included in mapping are small areas of Real and Houston Black soils. They make up less than 30 percent of a mapped area.

The soils in this complex are used as cropland, pastureland, and rangeland. They are moderately well suited to use as cropland. Small grains, including wheat, oats, and forage sorghums, are the main crops. The shallow rooting zone and the very low available water capacity of the Castephen soil are the main limitations to plant growth. Some plants are susceptible to lime-induced chlorosis, which is caused by the high content of lime in these soils.

The soils are well suited to use as pasture. They produce medium to high yields of improved pasture grasses if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

The Austin soil produces high yields of range forage, and the Castephen soil produces medium yields.

These soils provide habitat for openland wildlife, including quail, dove, rabbit, and birds. In most areas, cover is not available for deer and turkey.

There are limitations to use of the soils for urban development, including corrosivity to uncoated steel, low soil strength, which affects roads and streets, and the shallowness of the Castephen soil. The limitations can be partly overcome through good design and careful installation. Clayey texture, shallowness to rock, and, in places, slope are limitations to recreation uses.

These soils are in capability subclass IIIe. The Austin soil is in the Clay Loam range site, and the Castephen soil is in the Chalky Ridge range site.

**AuC3—Austin-Castephen complex, 2 to 5 percent slopes, eroded.** This complex consists of moderately deep, clayey Austin soil and shallow, loamy Castephen soil. These soils are gently sloping and are on uplands in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are irregular in shape and range from 10 to 50 acres in size. There are gullies throughout the areas. Most gullies are less than 2 feet deep and 3 to 5 feet wide. They are 200 to 600 feet apart. Sheet erosion has removed 25 to 50 percent of the surface layer in most areas between the gullies.

Austin silty clay makes up 45 to 75 percent of the complex, but on the average it makes up 60 percent. Castephen silty clay loam makes up 15 to 55 percent, but the average is 30 percent. Real, Heiden, and other soils make up less than 5 percent to 25 percent, but the average is 10 percent. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Austin soil is dark grayish brown silty clay about 10 inches thick. The subsoil to a depth of 14 inches is grayish brown silty clay; to a depth of 23 inches it is pale brown silty clay; and to a depth of 28 inches it is very pale brown silty clay. There are many chalk pebbles in the lower part of the subsoil. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Austin soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is low. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Typically, the surface layer of the Castephen soil is dark grayish brown silty clay loam about 9 inches thick. The layer below that, to a depth of 18 inches, is grayish brown silty clay loam; it has many chalk pebbles in the lower part. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Castephen soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

These soils are used mainly as rangeland. In a few areas they are used as cropland. Oats, wheat, and forage sorghums are the main crops.

The soils are poorly suited to use as cropland. The shallow rooting zone and the very low available water capacity of the Castephen soil are the main limitations. Low fertility, resulting from erosion, is also a limitation. Some plants are susceptible to lime-induced chlorosis, which is caused by the high content of lime in these soils. Crop residue left on the surface, cover crops, and terraces help control erosion.

These soils are well suited to use as pasture. They produce medium to high yields of improved pasture grasses. Good management includes proper stocking and controlled grazing.

The Austin soil produces high yields of range forage, and the Castephen soil produces medium yields.

These soils provide habitat for openland wildlife, including quail, dove, rabbit, and birds. In most areas, cover is not available for deer and turkey.

There are limitations to use of the soils for urban development, including corrosivity to uncoated steel, low soil strength, which affects roads and streets, and the shallowness of the Castephen soil. The limitations can be partly overcome through good design and careful installation. Clayey texture, shallowness to rock, and slope are limitations to recreation uses.

These soils are in capability subclass IVe. The Austin soil is in the Clay Loam range site, and the Castephen soil is in the Chalky Ridge range site.

**BoB—Boerne fine sandy loam, 1 to 3 percent slopes.** This is a deep, gently sloping soil on convex slopes of low stream terraces near rivers and large creeks. Most areas are long and narrow. Some are oblong. The areas range from 5 to 40 acres in size.

Typically, the surface layer is grayish brown, moderately alkaline fine sandy loam about 17 inches thick. The subsoil extends to a depth of 41 inches and is pale brown and very pale brown, moderately alkaline fine sandy loam. It is about 50 percent calcium carbonate (lime). The underlying material to a depth of 65 inches is very pale brown, moderately alkaline fine sandy loam.

This soil is well drained. Surface runoff is slow. Permeability is moderately rapid, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight to moderate hazard. This soil is flooded only rarely.

Included with this soil in mapping are small areas of Sunev silty clay loam and Seawillow soils. Also included are areas of soils that are similar to Boerne soils. One of the similar soils has a dark colored surface layer, and the other is more than 35 percent gravel in the subsoil. The included soils make up less than 10 percent of a mapped area.

This soil is used mainly for pasture. In a few areas it is used as cropland or rangeland.

The soil is moderately well suited to use as pasture. Moderate yields can be expected if good management is practiced. Improved bermudagrass and improved bluestem are the main grasses. These grasses respond well to fertilizer.

If this soil is used as rangeland, it produces medium yields of forage if good management is practiced.

Boerne soil is moderately well suited to cultivated crops. Moderate yields can be expected if good management is practiced. The main crops are small grains and forage sorghum. The medium available water capacity and the susceptibility of some plants to lime-induced iron chlorosis caused by an excessive amount of calcium carbonate are limitations. Fertilization and proper residue management increase the content of organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed in most areas to control erosion. Grassed waterways safely remove runoff from the terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Adequate cover is not available for deer and turkey.

Seepage and corrosivity to uncoated steel are limitations for urban uses. These limitations can be overcome through good design and careful installation. Flooding, although rare, is a limitation that must be considered in planning permanent installations. The possibility of flooding is a limitation for camp areas. In some places, slope is a limitation for playgrounds.

This soil is in capability subclass IIe and in the Loamy Bottomland range site.

**BrB—Bolar clay loam, 1 to 3 percent slopes.** This is a moderately deep, gently sloping soil on concave valley slopes and foot slopes of hills on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are mostly long and narrow and range from 5 to 350 acres in size.

Typically, the surface layer is dark grayish brown and dark brown clay loam about 14 inches thick. The subsoil extends to a depth of 28 inches. It is brown clay loam; it is about 50 percent calcium carbonate (lime). Indurated limestone interbedded with marl is at a depth of 28 inches. This soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is low. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Krum, Denton, Doss, and Sunev soils. Also included are small areas of eroded Bolar soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is used for crops and pasture. This soil is well suited to use as pasture. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. The limitations include the moderately deep rooting zone and the low available water capacity. Good management includes proper stocking and controlled grazing.

This soil produces high yields of range forage if good management is practiced.

This soil is moderately well suited to use as cropland. Low to medium yields can be expected if good management is practiced. The main crops are oats and forage sorghums. The limitations are the low available water capacity, the moderate hazard of erosion, and the susceptibility of some plants to lime-induced chlorosis, which is caused by an excessive amount of calcium carbonate. Fertilizer and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps conserve moisture, prevent runoff, reduce compaction,

and conserve energy. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This Bolar soil provides fair habitat for wildlife. In some areas, cover is not available for deer, turkey, and quail.

The moderate depth to rock, corrosivity to uncoated steel, and the shrink-swell potential are limitations for urban uses. The limitations can be partly overcome through good design and careful installation. Slope, in some places, is a limitation for playgrounds.

This soil is in capability subclass IIe and in the Clay Loam range site.

**BtD—Brackett-Rock outcrop-Comfort complex, undulating.** This complex consists of shallow, loamy and clayey soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 1 to 8 percent. The mapped areas consist of either a single low hill in oval areas or a series of low hills in irregularly shaped areas. Many areas have a benched appearance along the hill slopes because of the horizontal bands of Rock outcrop. The Brackett and Comfort soils are between the bands of Rock outcrop. The mapped areas range from 25 to 3,000 acres in size.

The Brackett soil makes up 30 to 60 percent of the complex, but on the average it makes up 50 percent. Rock outcrop makes up 10 to 45 percent, but the average is 20 percent. The Comfort soil and similar soils make up 10 to 20 percent, but the average is 15 percent. Purves soils in benched areas and Bolar and Doss soils in narrow valleys make up as much as 15 percent of a mapped area. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Brackett soil is grayish brown gravelly clay loam about 6 inches thick. The subsoil extends to a depth of 17 inches. It is very pale brown and pale yellow gravelly clay loam. The underlying material is weakly cemented limestone interbedded with thin layers of indurated limestone. The soil is moderately alkaline and calcareous throughout.

Typically, the areas of Rock outcrop consist of exposures of limestone bedrock. There is some soil material in the narrow fractures in the rock. In some areas, however, the rock is flat and is covered by soil material as much as 3 inches thick.

Typically, the surface layer of the Comfort soil is dark brown extremely stony clay about 4 inches thick. The subsoil extends to a depth of 11 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

The soils in this complex are well drained. Surface runoff is medium to rapid. Permeability is moderately slow in the Brackett soil and slow in the Comfort soil. The available water capacity is very low. The rooting zone is shallow. Water erosion is a severe hazard. Seeps are common along the slopes after heavy rainfall.

The soils are used as rangeland and as habitat for wildlife. Rangeland forage production is limited because of the very low available water capacity and the shallow rooting zone. Medium yields of native range grasses can be expected if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Juniper readily invades if the grasses are overgrazed.

These soils provide fair habitat for rangeland wildlife. They provide adequate cover and food for deer, turkey, and quail.

The soils are not suited to use as pastureland or cropland. The medium to rapid runoff, the very low available water capacity, the shallow rooting zone, and the outcrops of rock are severe limitations.

The limitations to use of the soils for urban and recreation uses are severe and generally are difficult to overcome. The limitations are shallowness to rock, low soil strength, which affects roads and streets, corrosivity to uncoated steel, outcrops of rock, and slope.

Brackett and Comfort soils are in capability subclass VIs. The Brackett soil is in the Adobe range site, and the Comfort soil is in the Low Stony Hills range site. Rock outcrop is not assigned to a capability subclass or a range site.

**BtG—Brackett-Rock outcrop-Real complex, steep.** This complex consists of shallow, loamy soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 8 to 30 percent. Escarpments and high rounded hills and ridges and their side slopes are characteristic of the areas (fig. 7). Slopes have a benched appearance because of the horizontal layers of Rock outcrop. The Real and Brackett soils are between the areas of Rock outcrop. The mapped areas range from 50 to 6,000 acres in size.

The Brackett soil makes up 20 to 55 percent of the complex, but on the average it makes up 35 percent. Rock outcrop makes up 10 to 46 percent, but the average is 25 percent. The Real soil makes up 10 to 30 percent, but the average is 20 percent. Eckrant soils on hilltops and Bolar and Sunev soils in narrow valleys make up 10 to 30 percent, but the average is 20 percent. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Brackett soil is grayish brown gravelly clay loam about 6 inches thick. The subsoil extends to a depth of 14 inches. It is light gray gravelly clay loam. The underlying material is weakly cemented limestone interbedded with thin strata of pale yellow and very pale brown shaly clay. The soil is moderately alkaline and calcareous throughout.

**Figure 7.—An area of Brackett-Rock outcrop-Real complex, steep. The soils in this complex are used mainly as rangeland.**

Typically, Rock outcrop is barren of soil except in narrow fractures in the rock. In some areas the rock is flat and has as much as 3 inches of soil material on the surface.

Typically, the surface layer of the Real soil is very dark grayish brown gravelly clay loam about 12 inches thick. The upper part is about 20 percent, by volume, weakly cemented limestone gravel, and the lower part is about 60 percent. The underlying material is weakly cemented limestone.

The soils in this complex are well drained. Surface runoff is rapid. Permeability is moderately slow in the Brackett soil and slow in the Real soil. The available water capacity is very low. The rooting zone is shallow. Water erosion is a severe hazard. Seeps are common along the slopes after periods of heavy rainfall.

The soils are used as rangeland and as habitat for wildlife. Range forage production is severely limited because of the steep slopes, rapid runoff, the very low available water capacity, the shallow rooting zone, and the rock outcrops. Yields of native range grasses are low, even in favorable years and if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Juniper readily invades if the grasses are overgrazed.

These soils are not suited to pasture or crops. The steep slopes, shallow rooting zone, the very low available water capacity, rapid runoff, and the rock outcrops are severe limitations.

The soils provide cover and food for deer, turkey, and quail. Mature juniper provides nesting material for the golden-cheeked warbler, a rare species native to the survey area.

The limitations to use of the soils for urban and recreation uses are steep slopes, shallowness to rock, low strength, which affects roads and streets, corrosivity to uncoated steel, and the outcrops of rock. The limitations are difficult to overcome and can require expensive engineering procedures. In most areas, however, the view is scenic, increasing the desirability of the areas as sites for houses.

Brackett and Real soils are in capability subclass VIIs and in the Steep Adobe range site. Rock outcrop is not assigned to a capability subclass or a range site.

**ByA—Branyon clay, 0 to 1 percent slopes.** This is a deep, nearly level soil on ancient high stream terraces in the Blackland Prairie Land Resource Area. Most areas are irregular in shape and range from 10 to 800 acres in size.

Typically, this soil has an upper layer of dark gray clay about 44 inches thick. Below that, to a depth of 60 inches, there is grayish brown clay with dark gray streaks, which are cracks that have filled with material from the upper layer. The underlying material, from 60 to 80 inches, is mottled very pale brown and pale yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is slow. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when the soil is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a slight hazard. The clayey texture of this soil makes it difficult to work. Some areas are flat and remain wet later in the spring, which can delay farming operations.

Included with this soil in mapping are small areas of Houston Black, Lewisville, and Krum soils. Also included are areas of soils that are similar to the Branyon soil. One of these has a gravelly surface layer and a very gravelly subsoil. The other similar soil is noncalcareous throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used for pasture and hay.

This soil is well suited to use as cropland. Grain sorghum, cotton, wheat, corn, and oats are the main crops. High yields can be expected if good management is practiced. Fertilizer and proper residue management increase organic matter, improve tilth, and maintain the level of fertility. Minimum tillage reduces compaction and conserves energy.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well on this soil. These grasses respond well to fertilizer. Good pasture management includes proper stocking, controlled grazing, and weed and brush management.

If this soil is used as rangeland, it can produce high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Most areas do not provide sufficient food and cover for deer and turkey.

There are limitations to use of the soil for urban development, including clayey texture, shrink-swell potential, the very slow permeability, corrosivity to uncoated steel, and low soil strength, which affects roads and streets. The limitations can be partly overcome through good design and careful installation. Cave-in is a hazard in deep excavations. Clayey texture and the very slow permeability are limitations to recreation uses.

This soil is in capability subclass IIw and in the Blackland range site.

**ByB—Branyon clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil on ancient high stream terraces in the Blackland Prairie Land Resource Area. Most areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the upper layer is dark gray clay about 48 inches thick. The layer below that, to a depth of 82 inches, is grayish brown clay. The underlying material to a depth of 94 inches is clay that has yellowish, brownish, and grayish mottles. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard. The clayey texture of this soil makes it difficult to work.

Included with this soil in mapping are small areas of Houston Black, Lewisville, and Krum soils. Also included are areas of a similar soil that has a gravelly surface layer and very gravelly subsoil and another similar soil that is noncalcareous throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used for pasture and hay.

This soil is well suited to use as cropland. Grain sorghum, cotton, corn, wheat, and oats are the main crops. High yields can be expected if good management is practiced. Fertilizer and proper residue management increase organic matter, improve tilth, maintain the level

of fertility, and help prevent erosion. Minimum tillage helps reduce compaction, prevent runoff, and conserve energy. Terraces and contour farming are needed to prevent erosion.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed and brush management.

If this soil is used as rangeland, it can produce high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including rabbits and small birds. Adequate cover for deer and turkey is not available in most places.

There are limitations to use of the soil for urban development, including clayey texture, shrink-swell potential, the very slow permeability, corrosivity to uncoated steel, and low soil strength, which affects roads and streets. The limitations can be partly overcome through good design and careful installation. Cave-in is a hazard in deep excavations. Clayey texture and the very slow permeability are limitations to recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

**CaC3—Castephen clay loam, 3 to 5 percent slopes, eroded.** This is a shallow, gently sloping soil on convex, smooth slopes on low hills and ridges in the Blackland Prairie Land Resource Area. The areas of this soil are irregular in shape and range from 8 to 85 acres in size. In most areas there are a few shallow gullies that are less than 3 feet deep and generally 500 to 1,000 feet apart.

Typically, the surface layer is dark grayish brown and brown, moderately alkaline clay loam about 16 inches thick. There are many chalk fragments less than 3 inches across in the lower part. White, platy chalk bedrock is at a depth of 16 inches.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Austin and Real soils and small areas of a soil that is similar to this Castephen soil except that it has a light colored surface layer. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. Forage yields are medium if good management is practiced.

This soil is moderately well suited to use as pastureland. The shallow rooting zone and the very low water holding capacity are the main limitations. Good management includes proper stocking, controlled grazing, and brush management.

This soil is poorly suited to use as cropland. Low yields can be expected, even if good management is practiced. The very low available water capacity, the shallow rooting zone, the moderate hazard of erosion, and the susceptibility of some plants to lime-induced chlorosis are limitations.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. In most areas, cover for deer and turkey is not available.

The limitations to use of the soil for urban development are shallowness to rock and corrosivity to uncoated steel. The limitations can be partly overcome through good design and careful installation. Shallowness to rock and slope are limitations to recreation uses.

This soil is in capability subclass IVe and in the Chalky Ridge range site.

**CrD—Comfort-Rock outcrop complex, undulating.** This complex consists of shallow, clayey soils and Rock outcrop on side slopes and on hilltops and ridgetops on uplands in the Edwards Plateau Land Resource Area. Slopes are convex. The areas are irregular in shape and range from 25 to 1,000 acres in size.

Comfort extremely stony clay makes up 49 to more than 95 percent of the complex, but on the average it makes up 70 percent. Rock outcrop and areas of soil less than 4 inches deep make up 5 to 36 percent, but the average is 15 percent. Rumple, Purves, Eckrant, and Real soils make up less than 5 to 30 percent, but the average is 15 percent. The areas of Rock outcrop are long, narrow horizontal bands on hill slopes and along small drains. The Comfort soil is between the bands of Rock outcrop. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Comfort soil is dark brown extremely stony clay about 6 inches thick. Cobbles and stones as much as 4 feet across cover about 45 percent of the surface. The subsoil extends to a depth of 13 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is mildly alkaline and noncalcareous throughout.

The Comfort soil is well drained. Surface runoff is slow to medium. Permeability is slow, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a slight hazard.

Typically, Rock outcrop is dolomitic limestone that is barren of soil except in narrow fractures in the rock. In some areas the rock is flat and has as much as 3 inches of soil material on the surface.

The soils in this complex are used as rangeland and as habitat for wildlife.

Production of range forage is low because of the restricted rooting depth, the very low available water capacity, and the cobbles and stones on the surface.

Texas persimmon and blueberry juniper invade if the range is overgrazed.

The soils are not suited to cultivated crops or pasture. The areas of Rock outcrop, cobbles and stones on the surface and in the soil, the limited rooting depth, and the very low available water capacity are severe limitations.

The soils are suited to use as wildlife habitat. They provide adequate food and cover for deer, turkey, and quail.

The stony surface layer, shallowness to bedrock, and corrosivity to uncoated steel are severe limitations to use of the soils for recreation purposes.

The Comfort soil is in capability subclass VIIs and in the Low Stony Hills range site. Rock outcrop is not assigned to a capability subclass or range site.

**DeB—Denton silty clay, 1 to 3 percent slopes.** This is a moderately deep, gently sloping soil on valley slopes on uplands in the Edwards Plateau Land Resource Area. Slopes are slightly convex to concave. The areas are long and narrow in shape and range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 14 inches thick. The layer below that extends to a depth of 25 inches and is dark brown silty clay. The subsoil extends to a depth of 33 inches. It is light yellowish brown silty clay. The underlying material to a depth of 36 inches is light brown and reddish yellow silty clay. It is underlain by fractured limestone interbedded with calcareous clayey marl. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Purves, Anhalt, Bolar, Sunev, and Krum soils. Also included are areas of a soil that is similar to this Denton soil except that it is underlain by hard, indurated limestone. The included soils make up less than 15 percent of a mapped area.

This soil is used as rangeland, pastureland, and cropland.

This soil is well suited to use as cropland. Medium to high yields can be expected if good management is practiced. Small grains and forage sorghums are the main crops. Good tilth and fertility can be maintained by using proper residue management, fertilization, and crop rotation. Minimum tillage helps prevent runoff, conserve moisture, reduce compaction, and conserve energy. Terraces and contour farming help prevent water erosion. Grassed waterways safely remove runoff from terraces.

This Denton soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

This soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban and recreational uses, clayey texture, high shrink-swell potential, low strength, which affects roads and streets, depth to rock, and corrosivity to uncoated steel are limitations that can be partly overcome through good design and careful installation.

This soil is in capability subclass IIe and in the Clay Loam range site.

**DeC3—Denton silty clay, 1 to 5 percent slopes, eroded.** This is a moderately deep, gently sloping soil on valley slopes on uplands in the Edwards Plateau Land Resource Area. Slopes are slightly convex to concave. The areas are long and narrow and range from 5 to 87 acres in size. Gullies are 1 to 3 feet deep and 200 to 500 feet apart.

Typically, the surface layer extends to a depth of 28 inches. It is dark grayish brown silty clay in the upper part and dark brown silty clay in the lower part. The subsoil extends to a depth of 31 inches and is grayish brown silty clay. The underlying material is fractured limestone interbedded with calcareous clayey marl.

This soil is well drained. Surface runoff is rapid. Permeability is slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is moderately deep. The fertility level has been lowered by erosion. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Purves, Anhalt, Bolar, Sunev, and Krum soils. The included soils make up less than 15 percent of a mapped area.

This soil was once used mainly as cropland. However, in most areas it is now used as pastureland. In some areas small grains and hay sorghums are still grown.

This soil is moderately well suited to use as cropland. The eroded condition of this soil resulting in low fertility is the main limitation. Proper residue management is needed to help prevent further erosion and improve tilth and fertility. Terracing and contour farming are also needed. Eroding gullies can be stabilized by shaping, smoothing, and revegetating.

This soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife. Cover in some areas may not be adequate for deer and turkey.

For urban and recreational uses, clayey texture, high shrink-swell potential, depth to rock, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design.

This soil is in capability subclass IIIe and in the Clay Loam range site.

**DoC—Doss silty clay, 1 to 5 percent slopes.** This is a shallow, gently sloping soil on convex slopes of low hills and ridges on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are generally irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 9 inches thick. The subsoil extends to a depth of 18 inches and is yellowish brown clay loam. About 50 percent of the subsoil is calcium carbonate (lime). The underlying material to a depth of 24 inches is weakly cemented limestone and marl. The soil is generally moderately alkaline and calcareous throughout; however, in a few areas the surface layer is noncalcareous.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Bolar, Brackett, Eckrant, and Purves soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland and cropland. In a few areas it is used for improved pasture.

This soil is well suited to use as pasture. Improved bluestems and kleingrass grow well. These grasses respond well to fertilizer. The shallow rooting zone and the low available water capacity are limitations. Good management includes proper stocking, controlled grazing, and brush management.

Yields of range forage are medium if good management is practiced.

This soil is moderately well suited to use as cropland. Moderate yields can be expected if good management is practiced. The main crops are oats and forage sorghums. The low available water capacity, the shallow rooting zone, the hazard of erosion, and lime-induced chlorosis caused by excess calcium carbonate are limitations. Fertilizer and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides fair habitat for openland wildlife, including quail, dove, rabbit, and small birds. In some areas, cover for deer and turkey is not available.

For urban uses, shallowness to rock, moderately slow permeability, low strength affecting roads and streets, and corrosivity to uncoated underground steel pipelines are limitations that can be partly overcome through good design and careful installation. For recreation uses, slope and depth to rock are the main limitations.

This soil is in capability subclass IIIe and in the Shallow range site.

**ErG—Eckrant-Rock outcrop complex, steep.** This complex consists of shallow, clayey soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 8 to 30 percent. The mapped areas consist of long, narrow slopes on high hills and ridges and along escarpments. The areas range from 50 to 2,000 acres in size.

The Eckrant soil makes up 50 to 80 percent of the complex, but on the average it makes up 70 percent. Rock outcrop makes up 9 to 30 percent, but the average is 20 percent. Bracket, Real, Rumple, and Purves soils make up less than 5 to 30 percent, but the average is 10 percent. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Eckrant soil is very dark gray extremely stony clay about 10 inches thick. It is about 35 percent, by volume, cobbles and stones in the upper part and about 75 percent, by volume, stones in the lower part. The underlying layer is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

Typically, Rock outcrop consists of barren exposures of indurated limestone. In a few areas as much as 4 inches of clayey soil material overlies the bedrock, and dark colored clay is in cracks and fractures.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a severe hazard.

The soils are used as rangeland and as habitat for wildlife. They are not suited to use as cropland or pastureland.

Forage yields on rangeland are low because of the very low available water capacity, the shallow rooting zone, rapid runoff, the rock outcrops, and the large number of stones in the soil. Wild persimmon and Ashe juniper invade the range if it is overgrazed.

The soils provide a fair amount of food and shelter for deer and turkey.

Stoniness, shallowness to rock, slope, and corrosivity to uncoated steel are severe limitations to use of the soils for urban development.

The Eckrant soil is in capability subclass VIIs and in the Steep Rocky range site. Rock outcrop is not assigned to a capability subclass or a range site.

**FeF4—Ferris clay, 5 to 20 percent slopes, severely eroded.** This is a deep, sloping to moderately steep soil on uplands. Slopes are convex. The areas are irregular in shape and range from about 10 to 400 acres in size. Gullies are scattered throughout the areas. They are 2 to

8 feet deep, 4 to 10 feet wide, and 50 to 300 feet apart. In most areas, sheet and rill erosion have removed 25 to 75 percent of the surface soil between the gullies.

Typically, the surface layer is grayish brown clay about 12 inches thick. The layer below that extends to a depth of 24 inches and is grayish brown clay mottled with light yellowish brown and pale olive. The layer below that extends to a depth of 35 inches and is mottled light gray and light yellowish brown clay. The underlying material to a depth of 60 inches is mottled pale olive, pale yellow, gray, and light yellowish brown shaly clay and shale. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Heiden, Altoga, and Houston Black soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it was once used as cropland; however, erosion has made it no longer suitable for use as cropland.

This soil is poorly suited to use as pastureland because of difficulty in establishing and maintaining an adequate grass cover.

On rangeland, native grasses produce high yields in favorable years if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

The control of erosion is critical on this soil. Gullies need to be stabilized by shaping, smoothing, and revegetating. Establishing a cover of improved bermudagrass helps prevent further erosion.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. It is poorly suited to use as habitat for deer and turkey because of a lack of cover and an adequate supply of food.

For urban uses, clayey texture, high shrink-swell potential, very slow permeability, rapid runoff, low strength affecting roads and streets, and corrosivity to underground steel pipelines are limitations. For recreational uses, slope and very slow permeability are the main limitations.

This soil is in capability subclass VIe and in the Eroded Blackland range site.

**GrC—Gruene clay, 1 to 5 percent slopes.** This is a shallow to very shallow soil on stream terraces. Slopes are convex. The areas are long and narrow in shape and range from 5 to 650 acres in size.

Typically, the surface layer is very dark grayish brown clay about 13 inches thick. The underlying material to a depth of 22 inches is strongly cemented, massive caliche containing embedded gravel. The underlying material to a depth of about 80 inches is very gravelly loam. The soil is mildly alkaline and noncalcareous above the cemented layer.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow in the surface layer and very slow in the cemented layer. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Lewisville, Krum, and Seawillow soils. Also included are areas of a soil that is similar to this Gruene soil except that it has a gravelly layer in the lower part that is not cemented and another similar soil that has a surface layer of gravelly clay loam. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is cultivated. Small grains and forage sorghums are the main crops.

On rangeland, forage yields of native range plants are medium if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

This soil is poorly suited to use as cropland and pastureland. The very low available water capacity and shallow to very shallow rooting zone are limitations.

This soil provides adequate food and cover for deer, turkey, and quail.

For urban uses, shallowness to the cemented layer and corrosivity to uncoated steel are severe limitations that are difficult to overcome. For recreation areas, slope and depth to rock are the main limitations. This soil is a source of sand and gravel for construction purposes.

This soil is in capability subclass IVs and in the Shallow range site.

**HeB—Heiden clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil mainly on upland ridges in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are long and narrow in shape and range from 8 to 300 acres in size.

Typically, the surface layer is dark grayish brown clay about 16 inches thick. The layer below that extends to a depth of 63 inches and is grayish brown clay that has light yellowish brown and olive mottles. The underlying layer to a depth of 72 inches is mottled grayish brown, pale yellow, and olive yellow shaly clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping and making up less than 15 percent of a mapped area are small areas of Houston Black and Altoga soils.

This soil is used mainly as cropland. In some areas it is used for improved pasture.

**Figure 8.—Grain sorghum is a major crop on Heiden clay, 1 to 3 percent slopes.**

This soil is well suited to use as cropland (fig. 8). Grain sorghum, cotton, and small grains are the main crops. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to prevent erosion.

This soil is well suited to use as pastureland. It produces high forage yields of improved pasture grasses in favorable years. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. It does not provide adequate food and cover for deer and turkey.

For urban uses, clayey texture, shrink-swell potential, low strength affecting roads and streets, corrosivity to uncoated steel, and very slow permeability are limitations which can be partly overcome through good design and careful installation. For recreational uses, very slow permeability and slope, in some places, are limitations.

This soil is in capability subclass IIe and in the Blackland range site.

**HeC3—Heiden clay, 3 to 5 percent slopes, eroded.** This is a deep, gently sloping soil on convex side slopes on low hills and ridges on uplands in the Blackland Prairie Land Resource Area. The areas of this soil are long and narrow or irregular in shape and range from 10 to 150 acres in size. Shallow gullies 1 to 4 feet deep and 200 to 500 feet apart are few to common in all mapped areas.

Typically, the surface layer is dark grayish brown clay about 13 inches thick. The layer below that extends to a depth of 58 inches and is grayish brown clay. The underlying material to a depth of 80 inches is pale yellow shaly clay that has brownish yellow and olive yellow mottles. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The fertility level has been reduced because of erosion. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Altoga, Houston Black, Ferris, and Tinn soils. Tinn soils are on narrow flood plains of small creeks. Also included are a few areas of Heiden soils that are only slightly eroded. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland. In some areas it is used as rangeland and cropland.

This soil is well suited to improved pasture grasses and native range plants. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management. Gullies need to be stabilized by shaping, smoothing, and revegetating.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil is well suited to use as cropland. Medium yields can be expected if good management is practiced. The main crops are oats, wheat, grain sorghum, and forage sorghums. The hazard of erosion, very slow permeability, poor tilth, and low fertility, especially near gullies, are limitations. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, very slow permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. Very slow permeability, clayey texture, and slope are limitations for recreation uses.

This soil is in capability subclass IIIe and in the Blackland range site.

**HeD3—Heiden clay, 5 to 8 percent slopes, eroded.** This is a deep, sloping soil on the steeper side slopes of hills and ridges in the Blackland Prairie Land Resource Area. The slopes are convex. Areas are mostly long and narrow in shape. They range from 5 to 150 acres in size. There are few to common gullies, 2 to 5 feet deep and 100 to 500 feet apart, in all mapped areas.

Typically, the upper layer is dark grayish brown clay about 28 inches thick. The layer below that extends to a depth of 57 inches and is grayish brown clay. The underlying material to a depth of 84 inches is light olive gray and pale olive shale. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The fertility level has been reduced because of erosion. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Ferris and Altoga soils. The included soils make up less than 10 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as cropland.

This soil is moderately well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management. Gullies need to be stabilized by shaping, smoothing, and revegetating.

On rangeland this soil produces high yields of forage if good management is practiced.

This soil is poorly suited to use as cropland. Low to medium yields can be expected if good management is practiced. Low fertility, poor tilth, rapid runoff, and the severe hazard of further erosion are limitations. The measures needed in cropped areas to adequately protect the soil from further erosion are costly. Protective measures include stabilization of existing gullies and installation of an extensive terrace system that includes grassed waterways and well designed outlets.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. Slippage is a potential problem when the soil is wet because of the slope and low strength. These limitations can be partly overcome through good design and careful installation. For recreation areas, clayey texture, very slow permeability, and slope are limitations.

This soil is in capability subclass IVe and in the Blackland range site.

**HgD—Heiden gravelly clay, 3 to 8 percent slopes.** This is a deep, gently sloping to sloping soil on the side

slopes of hills and ridges in the Blackland Prairie Land Resource Area. Slopes are convex. Areas are mostly long and narrow in shape and range from 10 to 170 acres in size.

Typically, the surface layer is 25 inches thick. The upper part is dark gray gravelly clay, and the lower part is dark grayish brown gravelly clay. The subsoil extends to a depth of 48 inches and is olive clay that has mottles of dark grayish brown and streaks of dark gray. The underlying material to a depth of 80 inches is pale yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard. The gravelly surface layer and the clayey texture make this soil difficult to work.

Included with this soil in mapping are small areas of Houston Black soils, small areas of Heiden clay, and a few areas where the soil is eroded in spots. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland and cropland.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil is moderately well suited to use as cropland. Grain sorghum, forage sorghum, oats, and wheat are the main crops. Medium yields can be expected if good management is practiced. Rapid runoff, very slow permeability, the hazard of erosion, and surface gravel are limitations. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, very slow permeability, low strength, which affects roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, the clayey texture, slope, very slow permeability, and gravelly surface layer are limitations.

This soil is in capability subclass IVe and in the Blackland range site.

**HoB—Houston Black clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil on narrow ridgetops and long smooth foot slopes on uplands in the Blackland Prairie Land Resource Area. Slopes are mostly convex. The mapped areas are irregular in shape and range from 25 to 2,000 acres in size.

Typically, the soil to a depth of about 50 inches is very dark gray clay. To a depth of 77 inches it is grayish brown clay. The underlying material is yellowish shaly clay. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep (fig. 9). Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Heiden soils, Altoga soils on uplands, and Tinn soils on the flood plains of small creeks. Also included are small areas of gravelly Houston Black soils and a few eroded spots. Very small areas of saline soils are also included. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly for cultivated crops. In some areas it is used as pastureland.

This soil is well suited to nonirrigated crops. Cotton, grain sorghum, and small grains are the main crops. High yields can be expected if good management is practiced. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Rotating cotton with other crops helps to prevent cotton root rot, which is prevalent in these soils.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass are adapted. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

Houston Black soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

For urban uses, clayey texture, very slow permeability, high shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that are difficult to overcome. Very slow

**Figure 9.—Cracks that are several feet deep form in this soil when it is dry. The soil is Houston Black clay, 1 to 3 percent slopes.**

permeability, clayey texture, and slope, in some places, are limitations for recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

**HvB—Houston Black gravelly clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil on upland ridgetops and long smooth side slopes in the Blackland Prairie Land Resource Area. Slopes are mostly convex. The areas are irregular in shape and range from about 5 to 650 acres in size.

Typically, this soil is very dark gray gravelly clay to a depth of about 36 inches and dark gray clay to a depth of 54 inches. The soil is moderately alkaline and calcareous throughout. Smooth cherty gravel covers about 40 percent of the surface.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard. Gravel in the surface layer and the clayey texture make this soil difficult to work.

Included with this soil in mapping are small areas of Heiden and Tinn soils. Also included are small areas where the soil is eroded and areas of Houston Black soils that have slopes of 3 to 5 percent. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly for cultivated crops and as pastureland. Cotton, grain sorghum, and small grains are the main crops.

This soil is well suited to nonirrigated crops. High yields can be expected if good management is practiced. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed to prevent erosion. Grassed waterways safely remove runoff from terraces.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Houston Black soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

The clayey texture, very slow permeability, high shrink-swell potential, low strength, which affects roads and streets, and corrosivity to uncoated steel are severe limitations to use of the soil for urban development. The limitations are difficult to overcome. The very slow permeability, clayey texture, gravel, and slope are limitations to recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

**HvD—Houston Black gravelly clay, 3 to 8 percent slopes.** This is a deep, sloping soil on convex side slopes of ridges in the Blackland Prairie Land Resource Area. The mapped areas are generally long and narrow or irregular in shape and range from 10 to 250 acres in size.

Typically, the upper layer is black gravelly clay about 36 inches thick. Below that, to a depth of 48 inches there is dark gray clay. The underlying layer to a depth

of 60 inches is shaly clay. About 20 percent of the surface is covered with smooth cherty gravel.

This soil is moderately well drained. Surface runoff is medium to rapid. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard. The gravel on the surface and the clayey texture make this soil difficult to till at most moisture levels.

Included with this soil in mapping are small areas of Heiden and Tinn soils. Tinn soils are on flood plains of small creeks. Also included are small areas of nongravelly Houston Black soil and a few areas of eroded soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland and rangeland. In a few areas it is cultivated.

This soil is moderately well suited to nonirrigated crops. The gravel on the surface, rapid runoff, and very slow permeability are the main limitations. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to control erosion.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass are adapted. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

The soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of the lack of cover and an adequate food source.

For urban uses, the clay content, very slow permeability, high shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations that are difficult to overcome. The clay content, very slow permeability, and slope are limitations for recreational uses.

This soil is in capability subclass IIIe and in the Blackland range site.

**KrA—Krum clay, 0 to 1 percent slopes.** This is a deep, nearly level soil on stream terraces and valley fills. Slopes are plane or slightly concave. The areas are mostly long and narrow or oblong in shape and range from 10 to 360 acres in size.

Typically, the surface layer is dark brown clay about 19 inches thick. The subsoil to a depth of 49 inches is brown clay, and to a depth of 69 inches it is yellowish brown clay. The underlying material to a depth of 80 inches is yellowish brown clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderately slow. Cracks form when the soil is very dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Bolar, Branyon, Denton, Lewisville, and Sunev soils at a slightly higher elevation than this Krum soil. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some small areas it is used as pastureland and rangeland.

This soil is well suited to use as cropland. Grain sorghum, wheat, oats, and corn are the main crops. High yields can be expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Minimum tillage reduces compaction and conserves energy.

This soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

Krum soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clay content, moderately slow permeability, shrink-swell potential, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. Clayey texture and moderately slow permeability are limitations for recreational uses.

This soil is in capability subclass IIs and in the Clay Loam range site.

**KrB—Krum clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil on stream terraces and valley fills. Slopes are plane or concave. Areas are long and narrow or oblong in shape and range from 10 to 400 acres in size.

Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil to a depth of 58 inches is grayish brown clay, and to a depth of 66 inches it is brown clay. The underlying material to a depth of 80 inches is pale brown clay. The soil is moderately alkaline and calcareous throughout.

The soil is well drained. Surface runoff is medium. Permeability is moderately slow. Cracks form when the soil is dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Bolar, Denton, Lewisville, Branyon, and Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used as pastureland and rangeland. The soil is well suited to these uses.

Grain sorghum, wheat, oats, and corn are the main crops. High yields can be expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Contour farming and terraces are needed to help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy.

Improved bermudagrasses, improved bluestems, and kleingrass are adapted pasture grasses. This soil produces high yields of improved pasture grass forage. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Krum soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clay content, shrink-swell potential, moderately slow permeability, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, moderately slow permeability, clayey texture, and slope are limitations.

This soil is in capability subclass IIe and in the Clay Loam range site.

**KrC—Krum clay, 3 to 5 percent slopes.** This is a deep, gently sloping soil on stream terraces and valley fills. Slopes are mostly concave. The mapped areas are long and narrow and range from 5 to 75 acres.

Typically, the surface layer is dark grayish brown clay about 22 inches thick. The subsoil to a depth of 31 inches is dark brown clay, and to a depth of 44 inches it is brown clay. The subsoil to a depth of 54 inches is light yellowish brown clay. The underlying material is brownish yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. Cracks form when the soil is dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Denton, Lewisville, and Medlin soils. The included soils make up less than 15 percent of a mapped area.

This soil is used as cropland, pastureland, and rangeland.

This soil is moderately well suited to use as cropland. Grain sorghum, wheat, oats, and corn are the main crops. Medium yields can be expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Contour farming and terraces are needed to help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy.

This Krum soil is well suited to use as pastureland. Improved bermudagrasses, improved bluestems, and kleingrass grow well. Good management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

Krum soil provides habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clayey texture, shrink-swell potential, moderately slow permeability, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, clayey texture, moderately slow permeability, and slope are limitations.

This soil is in capability subclass IIIe and in the Clay Loam range site.

**LeA—Lewisville silty clay, 0 to 1 percent slopes.** This is a deep, nearly level soil on plane to slightly convex slopes on stream terraces. The areas are irregular in shape and range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown, silty clay about 17 inches thick. The subsoil to a depth of 36 inches is brown silty clay, and to a depth of 54 inches it is yellowish brown silty clay. The underlying material to a depth of 61 inches is brown silty clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderate. The available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Krum, Branyon, Gruene, and Sunev soils. Also included are small areas of gently sloping Lewisville soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is irrigated. Grain sorghum, cotton, and small grains are the main crops. In some areas this soil is used for improved pasture and as rangeland.

This soil is well suited to use as irrigated and nonirrigated cropland. High yields can be obtained if good management is practiced. Fertilization and proper residue management help maintain good tilth and fertility.

This Lewisville soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem are adapted. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife, although cover is not adequate in some areas.

For urban uses, the clayey texture, shrink-swell potential, moderate permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. The clayey texture is a limitation for recreation uses.

This soil is in capability class I and in the Clay Loam range site.

**LeB—Lewisville silty clay, 1 to 3 percent slopes.** This is a deep, gently sloping soil on stream terraces. Slopes are convex. Areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 15 inches thick. The subsoil to a depth of 33 inches is light brown silty clay, and to a depth of 63 inches it is reddish yellow silty clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate. The available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Krum, Sunev, Seawillow, and Gruene soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is used as pastureland. In some areas it is used for improved pasture.

This soil is well suited to use as irrigated and nonirrigated cropland. Grain sorghum, cotton, and small grains are the main crops. High yields can be obtained if good management is practiced. Fertilization and proper residue management maintain good tilth and fertility and help prevent erosion. Contour farming and terracing are needed to prevent erosion.

This Lewisville soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife, although cover is inadequate in some areas.

For urban uses, the clayey texture, shrink-swell potential, moderate permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. For recreational uses, clayey texture and slope are the limitations.

This soil is in capability subclass IIe and in the Clay Loam range site.

**MEC—Medlin-Eckrant association, undulating.** This association consists of very shallow to shallow and deep soils on uplands in the Edwards Plateau Land Resource Area. The Medlin soil is on slightly concave slopes, and the Eckrant soil is on convex slopes. Slopes range from 1 to 8 percent. The mapped areas are irregular in shape and range from 25 to 500 acres in size.

The Medlin soil makes up 30 to 65 percent of the mapped areas, and the Eckrant soil makes up 20 to 60 percent. A typical area is 50 percent Medlin soil and 30 percent Eckrant soil. The Medlin soil is on the lower side slopes of low hills and ridges. The Eckrant soil is on the upper side slopes and on the crest of hills and ridges. Krum soils on toe slopes below the Medlin soil, Comfort soils on the crest of ridges, and narrow ledges of limestone bedrock on the upper side slopes make up about 20 percent of the mapped areas. The Medlin soil is eroded in about 15 percent of the areas. The composition of this association is more variable than that of other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the surface layer of the Medlin soil is grayish brown clay about 9 inches thick. The subsoil, to a depth of 24 inches, is olive clay and, to a depth of 38 inches, mottled pale olive and pale yellow clay. The underlying material to a depth of 80 inches is mottled olive, pale yellow, and brownish yellow shale. The soil is moderately alkaline and calcareous throughout.

The Medlin soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Typically, the surface layer of the Eckrant soil is dark brown extremely stony clay about 17 inches thick. The underlying material is fractured limestone bedrock. The soil is moderately alkaline and noncalcareous throughout.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a slight hazard.

The Eckrant soil is not suited to use as cropland or pastureland. Stones on the surface, limited rooting depth, and very low available water capacity are limitations. The Medlin soil is poorly suited to use as cropland and pastureland because of the hazard of erosion and very slow permeability. Yields are low in most years.

The Medlin and Eckrant soils are used as rangeland. High forage yields can be expected on the Medlin soil and medium yields on the Eckrant soil if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Wild persimmon and Ashe juniper tend to invade these soils if the range is overgrazed. In addition, mesquite will encroach on areas of the Medlin soil.

The Medlin soil is well suited to farm ponds and is used extensively for this purpose.

The Medlin and Eckrant soils provide habitat for deer, turkey, dove, and quail.

For urban uses, the slope, stoniness, the shallowness of the Eckrant soil, the moderately slow and very slow permeability, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that can be difficult and costly to overcome. For recreational uses, slope, shallowness to rock, very slow permeability, and stoniness are limitations.

The Medlin soil is in capability subclass VIe, and the Eckrant soil is in capability subclass VIIs. The Medlin soil is in the Blackland range site, and the Eckrant soil is in the Low Stony Hills range site.

**MED—Medlin-Eckrant association, hilly.** This association consists of very shallow to shallow and deep soils on uplands in the Edwards Plateau Land Resource Area (fig. 10). The Medlin soil is on slightly concave slopes, and the Eckrant soil is on convex slopes. There are narrow limestone ledges at the top of some slopes. The slopes range from 8 to 30 percent. The areas are long and narrow and range from 25 to 350 acres in size.

The Medlin and Eckrant soils each make up 20 to 80 percent of a mapped area. Together, on the average, they make up about 95 percent of a mapped area. A typical area is 50 percent Medlin soil and 45 percent Eckrant soil. The Medlin soil is on lower side slopes, and the Eckrant soil is on the upper side slopes and on the crest of narrow ridges. Krum soils on toe slopes below the Medlin soil and rock outcrops on the upper side slopes make up less than 20 percent of the mapped areas. The Medlin soil is eroded in about 15 percent of the areas. The composition of this association is more variable than that of other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the Medlin soil has a grayish brown surface layer about 11 inches thick that is stony clay in the upper part and clay in the lower part. The subsoil, from 11 to 50 inches, is light yellowish brown clay that has yellowish brown and olive yellow mottles. The underlying material to a depth of 80 inches is light gray shaly clay that has yellow and olive yellow mottles. The soil is moderately alkaline and calcareous throughout.

The Medlin soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Typically, the surface layer of the Eckrant soil is very dark gray extremely stony clay about 16 inches thick. The underlying material is fractured limestone bedrock. The soil is moderately alkaline and noncalcareous throughout.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a severe hazard.

These soils are used as rangeland. High forage yields can be expected on the Medlin soil and medium yields on the Eckrant soil if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Mesquite invades the Medlin soil, and Texas persimmon and Ashe juniper invade both the Eckrant and Medlin soils if the range is overgrazed.

The Medlin soil provides good sites for farm ponds and is used extensively for this purpose.

The Eckrant soil is not suited to use as cropland or pastureland. Slopes, stoniness, limited rooting depth, and very low available water capacity are severe limitations.

The Medlin and Eckrant soils provide habitat for deer, turkey, dove, and quail.

For urban and recreational purposes, the slope, stoniness, the shallowness of the Eckrant soil, the very slow permeability of the Medlin soil, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that can be difficult and costly to overcome.

These soils are in capability subclass VIIs. The Medlin soil is in the Blackland range site, and the Eckrant soil is in the Steep Rocky range site.

**Oa—Oakalla silty clay loam, rarely flooded.** This is a deep, nearly level soil on plane, smooth slopes on flood plains. Slopes are less than 1 percent. The areas are irregular in shape and range from about 10 to 700 acres in size.

Typically, the upper layer is grayish brown silty clay loam about 31 inches thick. The subsoil to a depth of 42 inches is brown silty clay loam, and to a depth of 62 inches it is yellowish brown silty clay loam. The underlying material is light yellowish brown silty clay loam. The soil is moderately alkaline and calcareous and about 40 percent calcium carbonate throughout.

This soil is well drained. Flooding is unlikely, although it can occur under abnormal weather conditions. Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville, Boerne, Seawillow, and Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used as pastureland and rangeland. It is well suited to these uses.

The main crops are wheat, oats, grain sorghum, and forage sorghums. Medium to high yields can be

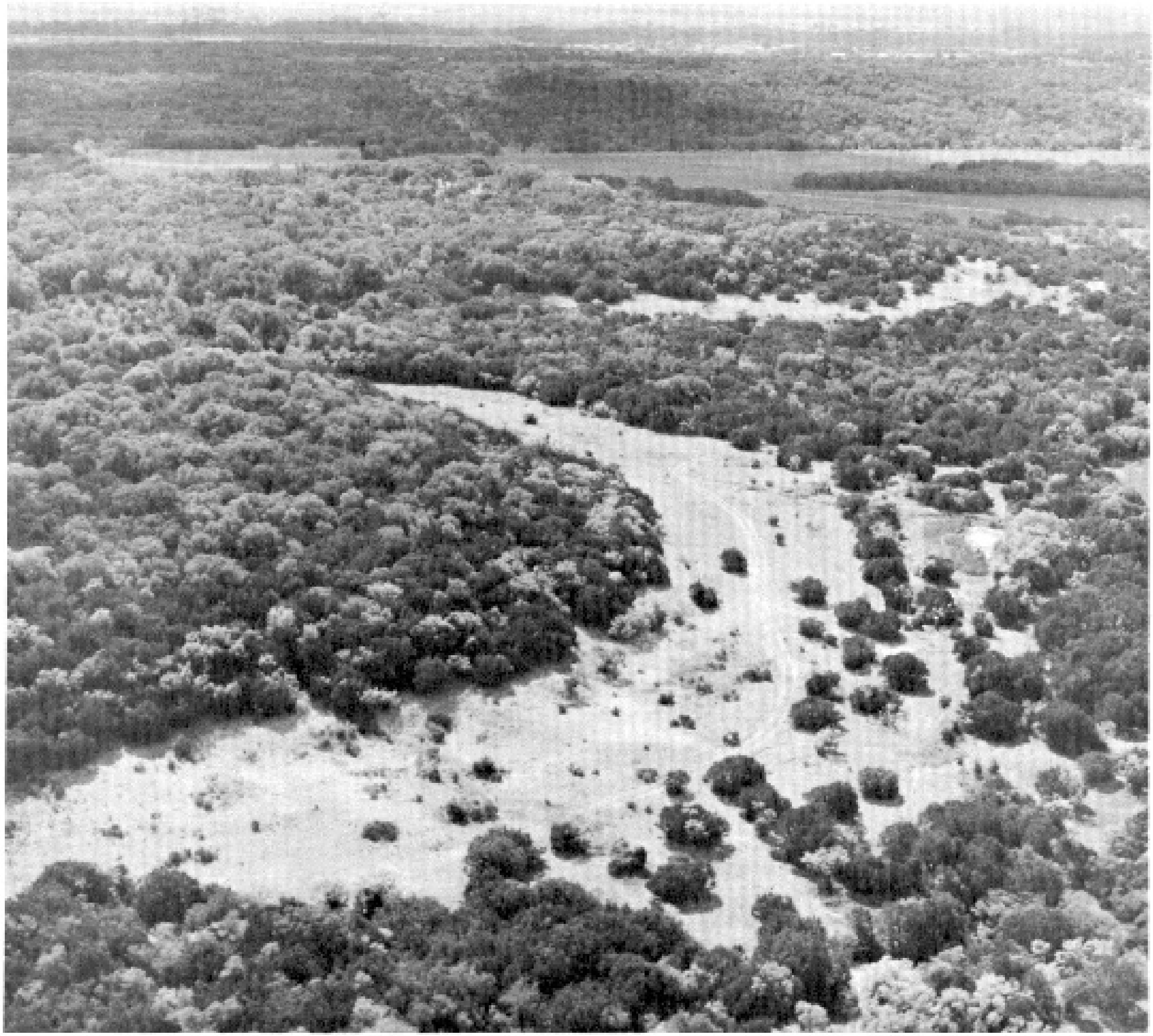

**Figure 10.—An aerial view of Medlin-Eckrant association, hilly. Medlin stony clay is in the open areas, and Eckrant extremely stony clay is in the wooded areas.**

expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Minimum tillage helps prevent runoff, conserve moisture, reduce compaction, and conserve energy.

High forage yields can be expected from improved pasture grasses if good management is practiced. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

This Oakalla soil provides good habitat for wildlife. Food and cover, however, are not adequate in areas that are cultivated.

This soil is not suited to urban uses because of the hazard of flooding. Excess lime is a limitation for landscape plants. Low strength, which affects roads and streets, and corrosivity to uncoated steel are other limitations. This soil is suited to some recreation uses, but flooding is a hazard.

This soil is in capability class I and in the Loamy Bottomland range site.

**Ok—Oakalla soils, frequently flooded.** These are deep, nearly level soils on plane, smooth to slightly undulating flood plains. Areas are long and narrow in shape and range from 5 to 200 acres in size. The surface texture of these soils is loam, clay loam, silty clay, or silty clay loam and does not vary in a uniform or regular pattern.

Typically, the upper layer to a depth of 40 inches is dark grayish brown clay loam. The subsoil to a depth of 49 inches is light yellowish brown clay loam. The underlying material to a depth of 80 inches is very pale brown clay loam. These soils are moderately alkaline and calcareous throughout. They are about 60 percent calcium carbonate (lime) throughout.

These soils are well drained. They are flooded more than once every 2 years for very brief periods. Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with these soils in mapping are small areas of a soil that is similar to the Oakalla soils except that it is more silty throughout. Also included are areas of a soil that has gravelly layers in the subsoil and in the underlying material. The included soils make up less than 15 percent of a mapped area.

Oakalla soils are not suited to use as cropland because of the hazard of flooding.

These soils are used as pastureland and rangeland. They are well suited to these uses. High yields can be expected from native range plants and improved pasture grasses if good management is practiced. Common bermudagrass and improved bermudagrass are well adapted. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

Oakalla soils provide fair habitat for wildlife. They produce adequate food and cover for deer, turkey, dove, quail, and many other nongame animals.

These soils are not suited to urban uses mainly because flooding is a hazard. Low strength affecting roads and streets and corrosivity to uncoated steel are limitations that are difficult and costly to overcome.

If these soils are protected from flooding they provide good sites for recreation (fig. 11).

These soils are in capability subclass Vw and in the Loamy Bottomland range site.

**Or—Orif soils, frequently flooded.** These are deep, nearly level soils on flood plains of large creeks and rivers. Slopes are convex and on the average are less than 1 percent. They are adjacent to the stream channel. The areas are long and narrow and range from 10 to 350 acres in size. The surface texture is gravelly loam, gravelly sandy loam, gravelly loamy sand, or a very gravelly counterpart. The texture does not vary in a regular pattern.

Typically, the surface layer is grayish brown, moderately alkaline gravelly loamy sand about 20 inches thick. The underlying layer to a depth of 60 inches is very gravelly loamy sand stratified with very gravelly sand, very gravelly sandy loam, and loam.

These soils are well drained. Flooding occurs several times in most years and is of very brief duration. Floodwaters are swift and destructive. Surface runoff is slow. Permeability is rapid. The available water capacity is low. The rooting zone is deep. Water erosion is a severe hazard.

Included with these soils in mapping are small areas of Oakalla soils on low ridges and areas of a soil that is similar to Orif soils except that it has a dark grayish brown gravelly loam surface layer. The included soils make up less than 15 percent of a mapped area.

These soils are used as rangeland and as a source of sand and gravel for road and building construction. They are not suited to use as pastureland or cropland because of flooding, the high content of gravel, and low available water capacity.

Orif soils produce medium yields of native range grass forage. The low available water capacity and low natural fertility limit the amount of forage produced in favorable years.

These soils provide fair habitat for the wildlife commonly found along creeks and rivers.

These soils are not suited to most urban and recreational uses because of the hazard of flooding.

Orif soils are in capability subclass VIs and in the Loamy Bottomland range site.

**PdB—Pedernales fine sandy loam, 1 to 5 percent slopes.** This is a deep, gently sloping soil on uplands on high, thin terraces along the Pedernales River. Slopes are convex. The areas are long and narrow in shape and range from 100 to 200 acres in size.

Typically, the surface layer is reddish brown, neutral fine sandy loam about 12 inches thick. The subsoil to a depth of 16 inches is reddish brown, neutral sandy clay, and to a depth of 40 inches it is mottled red and dark red, slightly acid sandy clay. The underlying material is light reddish brown sandy clay loam interbedded with weakly cemented limestone.

**Figure 11.—This area of Oakalla soils, frequently flooded, is protected from flooding and thus can be used for some kinds of recreation.**

This soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of a soil that has a loamy fine sand surface layer and areas of a soil that is less than 35 inches deep to limestone. Also included are some small areas of Pedernales gravelly fine sandy loam. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some small areas it is cultivated. In some areas it is being subdivided into small tracts for urban uses.

This soil is moderately well suited to use as cropland and it is well suited to use as pastureland. In most areas it is planted to oats for grazing. Forage yields on rangeland are high if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

Pedernales soil provides good habitat for deer, turkey, quail, and several species of nongame birds and small animals.

For urban uses, the moderately slow permeability, low strength, which affects roads and streets, and the clayey subsoil are limitations. The moderately slow permeability and slope are the main limitations for recreation uses.

This soil is in capability subclass IIIe and in the Tight Sandy Loam range site.

**Pt—Pits.** Pits are excavations from which rock, gravel, caliche, or clay has been removed. They range in size from 5 to 550 acres and in depth from about 10 to 100 feet. Pits smaller than 5 acres are identified by a spot symbol on the soil maps.

The surface material is residual rock, gravel, caliche, or clay that has been disturbed in excavation. The material ranges in thickness from a few inches to several feet where it is in piles.

The largest and deepest pits are rock quarries from which limestone has been excavated for use as commercial lime. Rock from other quarries has been used for road construction. The limestone that is taken from the newer pits is used in making cement. These pits are mainly in areas of the Comfort, Rumple, Eckrant, Austin, and Castephen soils.

Gravel pits are generally near large creeks and rivers. Large areas of Gruene soils and smaller areas of Lewisville, Krum, Oakalla, and Seawillow soils have been excavated for the underlying gravel. The gravel is used as construction material. Some of the pits have standing water most of the time.

Caliche pits are in the western half of the survey area in areas of interbedded marl and weakly cemented limestone. Most are small and shallow. The caliche is used mainly as the base material for paved roads or as the surface for caliche roads. These pits are mainly in areas of the Brackett, Real, and Doss soils.

Clay has been excavated from several pits near Interstate 35. The clay was used as fill material in constructing the highway. Most of these pits now hold water. They are in areas of the Branyon soils.

A few of the smaller pits near urban areas are being reclaimed by back-filling with material from nearby pits that are currently being excavated. A few of the larger pits can be reclaimed by spreading topsoil and seeding with a variety of drought-resistant range grasses.

Pits are not suited to use as cropland, pastureland, or rangeland or for recreation or urban uses. Slope, the roughness of the terrain, and coarse fragments, including gravel, cobbles, and stones, are the main limitations.

Some small animals, particularly rock squirrel, live in abandoned rock quarries.

Pits are not assigned to a capability subclass or a range site.

**PuC—Purves clay, 1 to 5 percent slopes.** This is a shallow, gently sloping soil on uplands. Slopes are plane to slightly convex. Areas are long and narrow in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark gray clay about 10 inches thick. The layer below that to a depth of 16 inches is dark gray clay, and to a depth of 19 inches it is dark grayish brown clay that is about 10 percent, by volume, coarse fragments of limestone. The underlying layer is fractured indurated limestone bedrock.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. The available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Doss, Brackett, and Eckrant soils. Also included are a few areas of Rock outcrop. The included soils make up less than 15 percent of a mapped area.

Purves soil is used mainly as rangeland. In a few areas it is used as pastureland and cropland. Small grains and forage sorghums are the main crops.

This soil is moderately well suited to use as pastureland. The shallow rooting depth and the very low available water capacity are limitations. King Ranch bluestem, Kleberg bluestem, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

This soil produces medium yields of range forage if good management is practiced.

This soil is poorly suited to use as cropland. The shallow rooting depth and the very low available water capacity are the main limitations. The available water capacity can be increased, and good tilth and fertility can be maintained if proper residue management is used.

This soil provides fair habitat for most openland wildlife.

For urban and recreational uses, the clayey texture, high shrink-swell potential, shallowness, and slope are severe limitations that can be difficult to overcome and can require expensive construction measures.

This soil is in capability subclass IVe and in the Shallow range site.

**RaD—Real gravelly loam, 1 to 8 percent slopes.** This is a shallow, gently sloping to sloping soil on convex slopes of low hills and ridges on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are irregular in shape and range from 75 to 600 acres in size.

Typically, the surface layer is 9 inches thick. It is dark grayish brown gravelly loam in the upper part and very gravelly loam in the lower part. The layer below that extends to a depth of 14 inches. It is dark grayish brown extremely stony loam. The underlying material is strongly cemented platy chalk. The soil is moderately alkaline and calcareous throughout. The calcium carbonate (lime) content is about 55 percent.

This soil is well drained. Surface runoff is rapid. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Eckrant, Comfort, and Doss soils. Local areas are underlain by indurated limestone. The included soils make up less than 15 percent of a mapped area.

This soil is used as rangeland and wildlife habitat. It is not suited to use as cropland or pastureland. The shallow rooting depth, high content of lime, and the very low available water capacity are severe limitations for crops and pasture grasses.

On rangeland, forage production from native range plants is low to medium. Good management includes

proper stocking, controlled grazing, and brush management.

This soil produces a limited amount of food for deer, turkey, and quail.

For urban and recreational uses, the shallowness of the soil, gravel, corrosivity to uncoated steel, and slope are the main limitations. These limitations can be difficult to overcome. Good design and careful installation are necessary.

This soil is in capability subclass VIs and in the Adobe range site.

**RcD—Real-Comfort-Doss complex, undulating.** This complex consists of shallow, loamy and clayey soils on low hills and ridges on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 1 to 8 percent. Mapped areas range from 25 to 3,000 acres in size.

The Real soil makes up 22 to 54 percent of the complex, but on the average it makes up 40 percent. The Comfort soil makes up 18 to 40 percent, but the average is 30 percent. The Doss soil makes up 9 to 39 percent, but the average is 20 percent. Eckrant, Purves, and Brackett soils and areas of Rock outcrop make up 1 to 19 percent, but the average is 10 percent. The soils are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Real soil is very dark grayish brown gravelly loam about 8 inches thick. The upper part is about 25 percent, by volume, angular gravel of limestone and caliche, and the lower part is about 55 percent fragments. The underlying material is weakly cemented limestone interbedded with thin layers of indurated limestone. The soil is moderately alkaline and calcareous throughout.

Typically, the surface layer of the Comfort soil is dark brown very stony clay about 7 inches thick. The subsoil extends to a depth of 13 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

Typically, the surface layer of the Doss soil is dark brown clay loam about 7 inches thick. The subsoil extends to a depth of 12 inches. It is reddish brown clay loam that is about 15 percent limestone and caliche gravel. The underlying material is weakly cemented limestone and marl. The soil is moderately alkaline and calcareous throughout.

The soils in this complex are well drained. Surface runoff is medium to rapid. Permeability in the Real soil is moderate, in the Comfort soil it is slow, and in the Doss soil it is moderately slow. The available water capacity is very low in the Real and Comfort soils and low in the Doss soil. Erosion is a moderate hazard. The rooting zone is shallow.

The soils in this complex are used as rangeland and wildlife habitat. Under good range management, they produce medium yields of forage. Production is limited because of the restricted rooting depth and the very low available water capacity. Ashe juniper invades these soils if the range is overgrazed. Good management includes proper stocking, controlled grazing, and brush management.

These soils provide a fair amount of food and cover for deer, turkey, and quail.

The soils in this complex are not suited to use as cropland and are poorly suited to use as pastureland. The shallow rooting zone, the very low available water capacity, and small areas of rock outcrop are severe limitations for cultivated crops.

For urban and recreation uses, shallowness, small stones, slope, low strength affecting roads and streets, and corrosivity to uncoated steel are the major limitations. These limitations can be difficult to overcome. Good design and careful installation are required.

These soils are in capability subclass VIs. The Real soil is in the Adobe range site, the Comfort soil is in the Low Stony Hills range site, and the Doss soil is in the Shallow range site.

**RUD—Rumple-Comfort association, undulating.** This association consists of shallow and moderately deep soils on uplands in the Edwards Plateau Land Resource Area. Slopes are plane or convex and range from 1 to 8 percent. The areas are irregular in shape and range from 50 to several thousand acres in size.

Rumple soil makes up about 60 percent of the association, Comfort soil makes up 20 percent, and other soils, mainly Tarpley soils, make up 20 percent. The Rumple soil makes up 39 to 82 percent of the individual areas, the Comfort soil makes up 5 to 42 percent, and the other soils make up less than 5 to 34 percent. The Rumple soil is on broad ridgetops and side slopes. It is mainly gently sloping. The Comfort soil is mainly in the more sloping areas near drainageways and near outcrops of rock. In places, there are narrow ledges of limestone. The mapped areas of this association are much larger and more variable than areas of the other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the surface layer of the Rumple soil is dark reddish brown very cherty clay loam about 10 inches thick. Rounded chert and limestone cobbles and gravel cover about 20 percent of the surface. The subsoil to a depth of 14 inches is dark reddish brown very cherty clay, and to a depth of 28 inches it is dark reddish brown extremely stony clay that is about 75 percent, by volume, limestone fragments. The underlying material is indurated fractured limestone. The soil is mildly alkaline and noncalcareous throughout. The texture of the surface layer ranges to very cherty loam and cherty clay.

Typically, the surface layer of the Comfort soil is dark brown, neutral, extremely stony clay about 7 inches

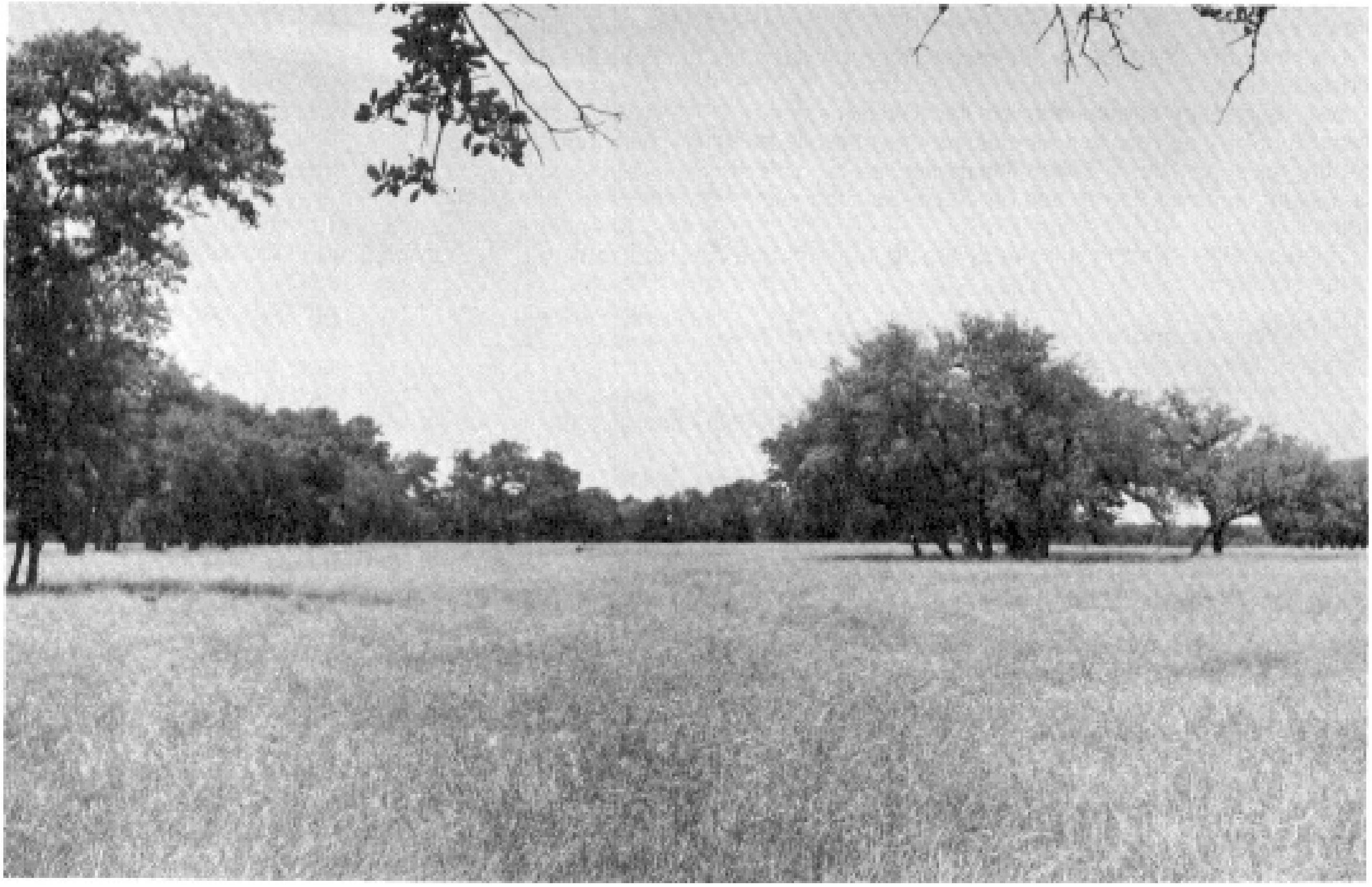

**Figure 12.—Rumple very cherty clay loam, in an area of Rumple-Comfort association, undulating, is used mainly as rangeland. This soil is in the Gravelly Redland range site.**

thick. The subsoil to a depth of 12 inches is dark reddish brown, mildly alkaline, extremely stony clay. The underlying material is indurated fractured limestone. The soil is noncalcareous throughout.

The soils in this association are well drained. Surface runoff is medium. However, runoff from large areas is much slower than from local areas because some of the water enters caves, sinks, rock crevices, and streambeds. Permeability is moderately slow in the Rumple soil and slow in the Comfort soil. The available water capacity is very low. The rooting zone is shallow in Comfort soil and moderately deep in Rumple soil. Water erosion is a moderate hazard.

These soils are used as rangeland and as habitat for wildlife (fig. 12). They are not suited to cultivated crops or pasture. Cobbles and stones on the surface and within the soil, the limited rooting zone, and the very low available water capacity are severe limitations.

Yields of range forage are medium. Forage production is limited because of the restricted rooting depth and the very low available water capacity. Good management includes proper stocking, controlled grazing, and brush control. Texas persimmon and Ashe juniper invade on the Comfort soil, and mesquite invades on the Rumple soil if the range is overgrazed. Cattle tend to graze the grasses more closely on the Rumple soil than on the Comfort soil. On the Comfort soil, the grasses generally are not overgrazed because of the large stones in the grassed areas. Therefore, stocking rates for proper grazing can be keyed to the Rumple soil.

The soils provide fair habitat for deer, turkey, and quail.

The stony surface layer, shallowness to bedrock, and corrosivity to uncoated steel are severe limitations to use of the soils for urban and recreation uses. The limitations are difficult to overcome.

These soils are in capability subclass VIs. The Rumple soil is in the Gravelly Redland range site, and the Comfort soil is in the Low Stony Hills range site.

**SeB—Seawillow clay loam, 1 to 3 percent slopes.** This is a deep, gently sloping soil on low ridges on stream terraces. Slopes are convex. The areas are mostly long and narrow in shape and range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown clay loam about 11 inches thick. The subsoil to a depth of 26 inches is very pale brown clay loam. About 70 percent of this layer is calcium carbonate (lime). The underlying material to a depth of 60 inches is very pale brown clay loam. The soil is moderately alkaline and limy throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville and Boerne soils and a soil that is similar to this Seawillow soil except that it has a dark colored surface layer. The included soils make up less than 15 percent of a mapped area.

This soil is used as cropland, pastureland, and rangeland.

The soil is moderately well suited to use as pastureland. It produces medium yields of improved pasture grasses, for example, improved bermudagrasses and improved bluestems. Good management includes proper stocking, controlled grazing, weed control, and fertilization.

This soil produces high yields of range forage if good management is practiced.

This soil is moderately well suited to use as cropland. Forage sorghums, wheat, and oats are the main crops. Low to medium yields can be expected if good management is used. The susceptibility of some plants to lime-induced iron chlorosis caused by excessive calcium carbonate is a limitation. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming is needed to prevent erosion.

The Seawillow soil provides habitat for openland wildlife. In most areas, however, cover for deer and turkey is not adequate.

This soil is suited to septic tank absorption fields and area landfills. Sites near streams should be avoided because of the risk of contamination. Seepage, corrosivity to uncoated steel, and low strength, which affects roads and streets, are moderate limitations to use of the soil for urban uses. The limitations can be partly overcome through good design and careful installation. Slope is the only limitation for recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

**SeD—Seawillow clay loam, 3 to 8 percent slopes.** This is a deep, gently sloping to sloping soil on stream terraces. Slopes are convex. These areas are long and narrow or oblong in shape and range from 5 to 80 acres in size.

Typically, the surface layer is brown clay loam about 8 inches thick. The subsoil to a depth of 38 inches is very pale brown clay loam. About 58 percent of this layer is calcium carbonate (lime). The underlying material to a depth of 80 inches is very light brown gravelly clay loam. The soil is moderately alkaline and limy throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Lewisville and Gruene soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as pastureland and cropland.

This soil is poorly suited to use as cropland. Erosion is a severe hazard. Crop yields are generally low. Oats and forage sorghums are the main crops. Some plants are affected by lime-induced iron chlorosis.

This soil is moderately well suited to use as pastureland. It produces medium forage yields of improved pasture grasses if good management is practiced. Good management includes proper stocking, controlled grazing, brush management, and fertilization.

On rangeland, this soil produces high yields of forage if good management is practiced.

The soil provides habitat for openland wildlife. In some areas, however, cover for deer and turkey is not adequate.

This soil is well suited to septic tank absorption fields and area landfills. Nevertheless, sites near streams should be avoided because of the risk of comtamination. Seepage, clayey texture, corrosivity to uncoated steel, and low strength, which affects roads and streets, are moderate limitations to use of the soils for urban uses. The limitations can be partly overcome through good design and careful installation. Slope is the main limitation for recreation uses.

This soil is in capability subclass IVe and in the Blackland range site.

**SuA—Sunev silty clay loam, 0 to 1 percent slopes.** This is a deep, nearly level soil on low stream terraces on uplands. Slopes are plane to slightly convex. The areas are mostly irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is brown silty clay loam about 15 inches thick. The subsoil to a depth of 33 inches is very pale brown silty clay loam, and to a depth

of 65 inches it is reddish yellow silty clay loam. The underlying material is reddish yellow silty clay loam. The soil is moderately alkaline and calcareous throughout. The subsoil is about 60 percent calcium carbonate.

This soil is well drained. Surface runoff is slow. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville, Seawillow, Boerne, and Gruene soils and small areas of gently sloping Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is used as pasture or rangeland.

This soil is moderately well suited to use as cropland. The main crops are oats, wheat, grain sorghum, and forage sorghums. Medium yields can be expected if good management is practiced. The high content of lime is the major limitation. The lime lowers the available water capacity and causes chlorosis in some plants, especially sorghums. Fertilization, proper residue management, and minimum tillage help conserve moisture, improve fertility, reduce compaction, and conserve energy. This soil is suited to irrigation.

This soil is well suited to use as pasture. Forage yields are high for pasture grasses, including improved bermudagrasses, improved bluestems, and kleingrass. These grasses respond well to fertilizer. Good management includes proper stocking, controlled grazing, and weed and brush control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides adequate food and cover for rangeland and openland wildlife. In cultivated areas, however, food and cover for deer and turkey may not be adequate.

For urban and recreational uses, slope, seepage, the clayey texture, and corrosivity to uncoated steel are moderate limitations. These limitations can be overcome through good design and careful installation.

This soil is in capability subclass IIs and in the Clay Loam range site.

**SuB—Sunev clay loam, 1 to 3 percent slopes.** This is a deep, gently sloping soil on valley slopes and foot slopes of hills on uplands in the Edwards Plateau Land Resource Area. Slopes are convex to concave and average 2 percent. The areas are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown clay loam about 11 inches thick. The subsoil to a depth of 35 inches is brown clay loam. To a depth of 45 inches, it is reddish yellow clay loam that is about 15 percent, by volume, soft masses and concretions of calcium carbonate. The soil is moderately alkaline and calcareous throughout. It is about 45 percent calcium carbonate (lime).

This soil is well drained. Surface runoff is medium to rapid. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a moderate hazard. This soil receives runoff from adjacent higher slopes.

Included with this soil in mapping are small areas of Bolar, Krum, Denton, and Lewisville soils, which are generally at a lower elevation. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is used as pasture or cropland.

This soil is well suited to use as cropland. Grain sorghum, oats, and forage sorghums are the main crops. Medium yields can be expected if good management is used. The high content of lime is the major limitation. It lowers the available water capacity and causes chlorosis in some plants, especially sorghums. Fertilization, proper residue management, and minimum tillage help conserve moisture, improve fertility, reduce compaction, and conserve energy.

This soil is well suited to use as pasture. Forage yields are high if good management is practiced. The main pasture grasses are improved bermudagrasses, improved bluestems, and kleingrass. These grasses respond well to fertilizer. Good management includes proper stocking, controlled grazing, and weed and brush control.

This soil produces high yields of range forage if good management is practiced.

This soil provides good habitat for wildlife. In cultivated areas, however, food and cover for deer and turkey may not be adequate.

For most urban and recreational uses, seepage, slope, and corrosivity to uncoated steel are the main limitations. These limitations can be overcome through good design and careful installation.

This soil is in capability subclass IIIe and in the Clay Loam range site.

**TaB—Tarpley clay, 1 to 3 percent slopes.** This is a shallow, gently sloping soil on plane to slightly concave slopes on uplands in the Edwards Plateau Land Resource Area. The areas are irregular in shape and range from 5 to 250 acres in size.

Typically, the surface layer is dark brown clay about 6 inches thick. The subsoil to a depth of 17 inches is dark reddish brown clay. The underlying layer is fractured, indurated limestone bedrock. The soil is neutral and noncalcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is slow. Water enters rapidly when the soil is dry and cracked and slowly when it is wet. The available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Anhalt and Rumple soils and a few small areas of Rock outcrop. Also included are areas of a soil that is similar

to this Tarpley soil except that it is underlain by gravel. In a few areas as much as 5 percent of the surface is covered with stones. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as pastureland and for cultivated crops.

This soil is moderately well suited to use as cropland. The shallow rooting zone and the very low available water capacity are limitations. Small grains and forage sorghums are the main crops.

This soil is moderately well suited to use as pastureland. The shallow rooting zone and the very low available water capacity are limitations. King Ranch bluestem, Kleberg bluestem, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

On rangeland, this soil produces high yields of forage if good management is practiced.

The soil provides habitat for rangeland wildlife. It produces a moderate amount of food and cover for deer, turkey, and quail.

For urban and recreational uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome. Good design and careful installation are required.

This soil is in capability subclass IIIe and in the Redland range site.

**Tn—Tinn clay, frequently flooded.** This is a deep, nearly level soil on flood plains along small streams. The areas are long and narrow in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark gray clay about 25 inches thick. The layer below that, to a depth of 80 inches, is grayish brown clay. The soil is moderately alkaline and calcareous throughout.

This soil is somewhat poorly drained. Surface runoff is very slow. Permeability is very slow. Water enters rapidly when the soil is dry and cracked. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The soil is very sticky when wet and very hard and cloddy when dry. Water erosion is a slight hazard. This soil is subject to frequent flooding. In some areas it is protected by flood prevention dams, and consequently flooding has been reduced.

Included with this soil in mapping are small areas of Branyon and Houston Black soils. The included soils make up less than 10 percent of a mapped area.

Tinn soil is used mainly as pastureland. In some areas it is used as cropland.

This soil is well suited to pasture grasses, for example, improved bermudagrasses, medio bluestem, and kleingrass. Good management includes fertilization, weed control, proper stocking, and controlled grazing.

This soil, where it is protected from frequent flooding, is well suited to use as cropland. Grain sorghum, wheat, oats, and cotton are the main crops. Very slow permeability and poor tilth are limitations. These conditions can be improved through proper residue management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good wildlife habitat for species that inhabit the areas along creeks and streams.

This soil is not suited to most urban and recreational uses because it is subject to frequent flooding. The very slow permeability, clayey texture, shrink-swell potential, and wetness are limitations which are difficult to overcome and can require expensive construction measures.

This soil is in capability subclass Vw and in the Clayey Bottomland range site.

# prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Comal and Hays Counties are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognized that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded during the growing season. The slope ranges mainly from 0 to 5 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 14 percent of Comal County, 52,910 acres, and 18 percent of Hays County, 77,327 acres, are prime farmland. The largest areas are in map units 3, 4, and 5 on the general soil map. Substantial areas of prime farmland are in map units 6 and 7, and small scattered areas are in units 1 and 2. Approximately 44,000 acres of prime farmland in Comal and Hays Counties is used for cultivated crops. The rest is used as pastureland or rangeland.

A recent trend in land use in some parts of the survey area has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Comal and Hays Counties. Some areas of these soils, however, are urban or built-up land, which is defined as any contiguous unit of land 10 acres or more in size that is used for nonfarm uses including housing, industrial, and commercial sites, sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water control structures. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

AnA Anhalt clay, 0 to 1 percent slopes
AnB Anhalt clay, 1 to 3 percent slopes
BrB Bolar clay loam, 1 to 3 percent slopes
ByA Branyon clay, 0 to 1 percent slopes
ByB Branyon clay, 1 to 3 percent slopes
DeB Denton silty clay, 1 to 3 percent slopes
HeB Heiden clay, 1 to 3 percent slopes
HoB Houston Black clay, 1 to 3 percent slopes
HvB Houston Black gravelly clay, 1 to 3 percent slopes
HvD Houston Black gravelly clay, 3 to 8 percent slopes [1]
KrA Krum clay, 0 to 1 percent slopes
KrB Krum clay, 1 to 3 percent slopes
KrC Krum clay, 3 to 5 percent slopes
LeA Lewisville silty clay, 0 to 1 percent slopes
LeB Lewisville silty clay, 1 to 3 percent slopes

Oa Oakalla silty clay loam, rarely flooded
PdB Pedernales fine sandy loam, 1 to 5 percent slopes
SuA Sunev silty clay loam, 0 to 1 percent slopes
SuB Sunev clay loam, 1 to 3 percent slopes

[1] Only those areas of Houston Black soils where the slopes are dominantly 3 to 5 percent are prime farmland.

# use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture and as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

## crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 32,500 acres in Comal County and 58,000 acres in Hays County were used for crops and pasture in 1980, according to records of the local office of the Soil Conservation Service. Of these totals, Comal County had about 8,400 acres in permanent pasture, 10,400 acres in row crops, and 13,700 acres in small grains. Hays County had about 38,000 acres in permanent pasture, 9,000 acres in row crops, and 11,000 acres in small grains. Pastures consisted mainly of King Ranch bluestem, Kleberg bluestem, and Coastal bermudagrass. To a lesser extent, medio bluestem and kleingrass were also grown for pasture. The main row crops were grain sorghum and cotton. Some corn was grown and so were oats and wheat.

The potential for increased food production is good. There is a large acreage of soils that are suited to use as cropland that is presently being used as rangeland and pastureland. In addition to the reserve productive capacity represented by that acreage, food production could be increased considerably by applying the latest crop production technology to all of the cropland in the survey area.

The acreage of the agricultural land in the survey area has gradually decreased as more land is used for urban development. It was estimated that in 1980 more than 57,000 acres in the survey area was urban or built-up land.

*Soil erosion* is the major soil problem on about 87 percent of the land suitable for cultivation. Where the slope is more than 1 percent, erosion is a hazard.

Erosion of the surface layer results in reduced productivity because the surface layer is the most productive part of the soil. Erosion is especially damaging to soils that have a thin surface layer, for example, Altoga, Bolar, Castephen, Doss, and Seawillow soils. It is also especially damaging to soils that do not have a deep rooting zone, for example, Anhalt, Austin, Bolar, Castephen, Denton, Doss, Gruene, Purves, and Tarpley soils.

Soil erosion also results in the sedimentation of streams. Controlling erosion minimizes the pollution of streams by sediment; thus, it improves the quality of

water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide a protective cover on the surface, reduce runoff, and increase infiltration. A cropping system that keeps plant cover on the soil for extended periods holds soil erosion losses to an amount that does not reduce the productive capacity of the soil. On livestock farms, where pasture and hay are required, legumes and grass forage crops in the cropping system help reduce erosion on sloping soils and improve soil tilth for the crop that follows. Furthermore, legumes add nitrogen to the soil.

Reduced tillage systems that leave crop residue on the surface help reduce runoff and erosion. Soil compaction is reduced because of fewer trips over the soil. Residue management and less soil disturbance reduce evaporation of moisture from the soil. Reduced tillage systems conserve energy because fewer tillage operations are used.

Terraces and diversions help prevent erosion by reducing the length of slope and safely removing runoff from the field. Most of the cultivated soils in the survey area are suitable for terraces and diversions. However, soils that have bedrock or a cemented layer within 20 inches of the surface, for example, Castephen, Doss, Gruene, Purves, and Tarpley soils, are not well suited to terraces and diversions.

Contour farming is a widespread method of controlling erosion. In fields that are not terraced, it is best adapted to soils that have smooth uniform slopes. Contour farming is most effective if combined with terraces.

Information on erosion control practices for each kind of soil in the survey area is available at local offices of the Soil Conservation Service.

*Fertility* is naturally high in soils on flood plains; Oakalla and Tinn soils, for example. It varies considerably on terrace and upland soils. For example, Boerne and Seawillow soils are naturally low in fertility, whereas Lewisville, Krum, Heiden, and Houston Black soils are moderately high in fertility.

Most of the cultivated soils in the survey area are low in nitrogen and phosphorus. Additions of fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired yields. The Cooperative Extension Service can help in determining the kind and amount of fertilizer to apply.

The soils that are cultivated are moderately alkaline and calcareous, except for Anhalt and Tarpley soils, which are noncalcareous and neutral or mildly alkaline. Soils that are calcareous have a moderate to high level of calcium carbonate (lime). Altoga, Austin, Bolar, Castephen, Doss, Oakalla, Seawillow, and Sunev soils have an excessive amount of lime. Lime-induced iron chlorosis, characterized by a yellowing of the leaves, is a problem in some plants on these soils.

*Soil tilth* is an important factor in the germination of seeds and in the movement of air, moisture, and roots. Soils that are granular and porous have good tilth. Tilth is improved by adding organic matter.

The common pasture grasses in the survey area are kleingrass, improved bermudagrasses, and improved bluestems. Fertilizer increases production and improves the quality of the forage. Controlling weeds and maintaining the proper grazing height help maintain plant vigor and healthy stands of grass.

A planned sequence of grazing and resting improves forage quality and production. Pasture can be used in combination with rangeland or cropland to ensure sufficient forage for the year. Forage that remains after grazing can be cut for hay, or the pasture can be left ungrazed and saved for hay.

## yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

## land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the

way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

*Capability classes*, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

*Capability subclasses* are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, wildlife habitat, or recreation.

## rangeland

Dalton Merz, range conservationist, Soil Conservation Service, helped prepare this section.

Rangeland consists of areas where the native vegetation includes a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. The vegetation generally is suitable for grazing, and the amount of vegetation is large enough to justify grazing. Rangeland, or native grassland, receives no regular or frequent cultural treatment. The composition and production of the plant community is determined by soil, climate, topography, overstory canopy, and grazing management.

According to records of the local office of the Soil Conservation Service, about 266,000 acres in Comal County and 335,000 acres in Hays County are used as rangeland or a combination of rangeland and wildlife habitat. The Blackland Prairie in the eastern part of the survey area was once an open prairie with trees near the streams and in a few scattered motts on adjacent uplands. The Edwards Plateau in the western part of the survey area was once a savannah characterized by tall and mid grasses, forbs, and trees, including live oak, shin oak, Spanish oak, and post oak.

The plant community of the rangeland in Comal and Hays Counties has changed drastically over the past 50 years. Much of the higher quality vegetation has been grazed out, and tall grasses flourish only in a few places. Short to mid grasses and poor quality forbs have replaced the tall grasses. However, in protected areas some of the original plant species remain. In most areas, high-quality plants can be reestablished if proper grazing management is practiced.

Most of the local ranches and livestock farms are cow-calf operations; some are stocker-calf enterprises. Many ranchers supplement their own cow herds with stockers, thus providing greater flexibility during periods of drought and grazing stress. Sheep and goats were once numerous in the survey area. Since the 1960's, however, few have been raised.

For most livestock operations, native grassland is supplemented by tame pasture and grazing crops. Coastal bermudagrass, kleingrass, and the Kleberg, medio, Gordo, and King Ranch bluestems are the common tame pasture grasses. Forage sorghums and small grains generally are grown on cropland to supplement the native rangeland.

Range forage production generally is highest during two distinct growth periods. Approximately 70 percent of the annual growth is produced in April, May, and June; spring rains and moderate temperatures promote the growth of warm season plants. A second growth period commonly occurs in September and October, resulting from the fall rains and gradually cooling temperatures. Droughts of varying length are frequent in the survey area. Each year, short midsummer droughts are normal, but droughts lasting many months can occur.

### range sites and condition classes

Soils vary in their capacity to produce grass and other plants for grazing. The soils making up each range site are similar in the kind, amount, and proportion of forage they produce.

Throughout the survey area, the climax vegetation consists of the plants that were in the region when it was first settled. If a site is characterized by at least 75 percent climax vegetation, the plant community is relatively stable, reproducing itself and varying very little in composition as long as the environment remains unchanged. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in proportion under close continuous grazing. Generally they are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in proportion as the more desirable decreaser plants are reduced by close grazing. Increasers commonly are shorter than decreasers and generally are less palatable to livestock.

Invaders are plants that ordinarily are not able to compete with other plants in the climax plant community for moisture, nutrients, and light. Invaders enter the plant community and grow in conjunction with increasers after the climax vegetation has been reduced by heavy continuous grazing. They generally are of little value for grazing. However, they can help protect the soil from erosion until the more desirable plants are reestablished.

Range condition is judged according to standards determined by the characteristics of the individual range site and is expressed as a comparison between the present kind and amount of vegetation and the climax plant community.

Four range condition classes are used to indicate the degree to which the present vegetation differs from the potential, or climax, vegetation as a result of grazing or other uses. A range is in *excellent* condition if 76 to 100 percent of the vegetation is similar to that in the climax stand; in *good* condition if the percentage is 51 to 75; in *fair* condition if the percentage is 26 to 50; in *poor* condition if the percentage is 25 or less.

Potential forage production depends on the characteristics of the range site. Current forage production depends on the condition of the range and the moisture available to plants during the growing season.

Table 6 shows, for each soil listed, the range site and the total annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

*Potential annual production* is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an average year, growing conditions are about normal. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

A primary objective of good range management is to keep the range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The main management concern is recognizing important changes in the kind of cover on a range site. Such changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall can lead to the conclusion that the range is in good condition when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, rangeland that has been closely grazed for short periods, temporarily may have a degraded appearance that conceals its high quality and its ability to recover.

After prolonged overuse of rangeland, seed sources of the desirable vegetation are eliminated. The vegetation can be reestablished by one or more of the following practices: brush control, range seeding, fencing, water development, or other mechanical treatment to revitalize stands of native plants. Thereafter, deferred grazing, proper grazing use, and a planned grazing system are necessary to maintain and improve the range.

The soils in the survey area have been assigned to 15 range sites. The range sites are described in the paragraphs that follow.

**Adobe range site.** The soils making up this range site are Brackett soils (BtD) and Real soils (RaD, RcD).

Grasses make up about 80 percent of the potential plant community, and woody plants and forbs make up the rest.

Typically, little bluestem makes up about 50 percent of the vegetation; indiangrass, 5 percent; sideoats grama and tall grama, 15 percent; other mid grasses, such as muhlys, green sprangletop, dropseeds, hairy grama, perennial threeawn, tridens, and sedges, 15 percent. Woody plants, such as live oak and Spanish oak, make up about 10 percent; and forbs, such as orange zexmenia, prairie-clover, daleas, and vetch, make up 5 percent.

Little bluestem, indiangrass, and sideoats grama are removed from the plant community by heavy grazing by livestock and are replaced by hairy grama, green sprangletop, tridens, perennial threeawn, and orange zexmania. If heavy grazing continues for many years, woody plants, such as Ashe juniper and agarita, and grasses and forbs, such as Texas grama, red grama, hairy tridens, tumblegrass, poverty dropseed, and queensdelight, can take over the site. In extreme cases, the juniper can become so dense that it nearly excludes other vegetation.

This site produces forage of low quality because of the limited phosphorus available to plants. Brush control and rotation grazing are particularly important on this site.

**Blackland range site.** The soils that make up this range site are Branyon soils (ByA, ByB), Heiden soils (HeB, HeC3, HeD3, HgD), Houston Black soils (HoB, HvB, HvD), Medlin soils (MEC, MED), and Seawillow soils (SeB, SeD).

The potential plant community is a tall grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiangrass and big bluestem, 25 percent; eastern gamagrass, switchgrass, Texas cupgrass, sideoats grama, wildrye, Texas wintergrass, and vine-mesquite, 10 percent; woody plants such as live oak, elm, and hackberry, 5 percent; and forbs such as Maximilian sunflower, Engelmann-daisy, gayfeather, bundleflower, snoutbeans, wildbeans, and western indigo, 10 percent.

Big and little bluestem, indiangrass, eastern gamagrass, switchgrass, Maximilian sunflower, and Engelmann-daisy are removed from the plant community through heavy grazing by livestock and are replaced by silver bluestem, Texas wintergrass, tall dropseed, sideoats grama, and less palatable forbs. If heavy grazing continues for many years, buffalograss, Texas wintergrass, mesquite, elm, Texas grama, croton, broomweed, and many composites dominate the site.

Mesquite and desert willow encroach in most places. Cool-season grasses, such as Texas wintergrass and rescuegrass, naturally fill the voids left when the shade and moisture competition drive out the tall warm-season grasses. In reestablishing formerly cropped areas, reseeding of desirable range grasses is necessary because of the lack of a natural seed source.

**Chalky Ridge range site.** The Castephen soils (AuB, AuC3, CaC3) make up this range site.

The potential plant community is a mid-grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiangrass, big bluestem, and wildrye, 20 percent; sideoats grama, silver bluestem, and dropseed, 15 percent; threeawn, slim tridens, fall switchgrass, and low panicum, 5 percent; and forbs such as gayfeather, bundleflower, penstemon, sensitivebrier, prairie-clover, vetch, and wild bean, 10 percent.

Little bluestem, big bluestem, indiangrass, and the palatable forbs are removed from the plant community through heavy grazing by livestock. These plants are replaced by sideoats grama, silver bluestem, threeawn, and less palatable forbs. If heavy grazing continues for many years, hairy grama, red grama, Texas grama, broomweed, baccharis, queensdelight, red threeawn, and hairy tridens will dominate the site. Most areas have scattered motts of live oak.

The vegetation on this site deteriorates more easily and quickly than that on most of the associated sites. Low-producing, coarse forbs and grasses invade if the range is continuously overgrazed. However, the range condition quickly improves if proper grazing management is practiced. In most places, this site recovers so quickly that it can provide a seed source for adjoining sites. Rotation grazing is the most important management practice on this site.

**Clayey Bottomland range site.** The Tinn soils (Tn) make up this range site.

The potential plant community is a savannah. Typically, switchgrass, indiangrass, big bluestem, and little bluestem make up 30 percent of the plant community; meadow dropseed, sideoats grama, vine-mesquite, and silver bluestem, 20 percent; wildrye, sedges, and Texas wintergrass, 20 percent; buffalograss, white tridens, Scribner panicum, and eastern gamagrass, 10 percent; woody plants such as live oak, elm, hackberry, pecan, willows, and western soapberry, 15 percent; and forbs, such as Maximilian sunflower, bundleflower, snoutbean, tickclover, and wild bean, 5 percent.

Eastern gamagrass, indiangrass, switchgrass, big bluestem, little bluestem, and Maximilian sunflower are removed from the plant community through grazing by livestock. Meadow dropseed, sideoats grama, silver bluestem, Texas wintergrass, vine-mesquite, buffalograss, and less palatable forbs are the initial increasers. If heavy grazing continues for many years, the overstory canopy thickens, and shade-tolerant species such as wildrye, sedges, and low panicum increase. If the rangeland is deteriorated, buffalograss, common bermudagrass, Texas grama, ragweed, sumpweeds, annual sunflower, cocklebur, broomweed, beebalm, iceweed, and croton dominate the site.

Some common bermudagrass and weeds as well as desirable tall range grasses and forbs are growing in most areas. Continuous close overgrazing causes bermudagrass and other low-growing plants to increase

and the desirable tall grasses to decrease. Grazing can be regulated to allow the tall range grasses to reseed and crowd out the less desirable bermudagrass.

**Clay Loam range site.** The soils making up this range site are Altoga soils (AgC3, AgD3), Austin soils (AuB, AuC3), Bolar soils (BrB), Denton soils (DeB, DeC3), Krum soils (KrA, KrB, KrC), Lewisville soils (LeA, LeB), and Sunev soils (SuA, SuB).

The potential plant community is a true prairie. Typically, little bluestem makes up 30 percent of the plant community; indiangrass, 10 percent; big bluestem, 5 percent; other mid grasses, such as tall dropseed, silver bluestem, sideoats grama, buffalograss, perennial threeawn, and Texas wintergrass, 50 percent; and forbs such as Engelmann-daisy, bundleflower, sensitivebrier, and bushsunflower, 5 percent.

Little bluestem, indiangrass, big bluestem, and Engelmann-daisy are removed from the plant community through overgrazing by livestock. These plants are replaced by sideoats grama and buffalograss. If heavy grazing continues, plants such as silver bluestem, perennial threeawn, and Texas wintergrass increase. Invaders, such as Ashe juniper and broomweed, follow.

This range site generally produces more forage and better grasses than adjacent sites. Consequently, livestock prefer this site to the others and tend to overgraze it sooner. If grazing is not controlled, grasses are replaced by brush such as agarita, persimmon, and Ashe juniper and by some elm and oak trees. Deferred grazing is an important practice in controlling brush and improving composition of the plant population.

**Deep Redland range site.** The Anhalt soils (AnA, AnB) make up this range site.

The potential plant community is a tall grass, post-oak savannah. The species composition, by weight, is 90 percent grasses, 5 percent forbs, and 5 percent woody plants.

Typically, little bluestem makes up 30 percent of the plant community; indiangrass, 15 percent; sideoats grama, 10 percent; other mid grasses such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, curlymesquite, and buffalograss, 25 percent; Texas wintergrass and Canada wildrye, 10 percent; woody plants such as post oak, blackjack oak, live oak, and greenbrier, 5 percent; and forbs such as Engelmann-daisy, bushsunflower, and sensitivebrier, 5 percent.

Little bluestem, indiangrass, and Engelmann-daisy are preferred by livestock and are removed from the plant community as a result of heavy grazing. These plants are replaced by sideoats grama, pinhole bluestem, buffalograss, and post oak. If continuous heavy grazing continues for many years, oaks increase to a dense stand and the understory consists of plants such as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite.

**Eroded Blackland range site.** The Ferris soils (FeF4) make up this range site.

The potential plant community is a tall grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiangrass and big bluestem, 20 percent; sideoats grama, wildrye, tall dropseed, silver bluestem, Texas wintergrass, and vine-mesquite, 15 percent; woody plants such as live oak, hackberry, and elm, 5 percent; and forbs such as Engelmann-daisy, Maximilian sunflower, gayfeather, snoutbean, and wildbean, 10 percent.

Little bluestem, indiangrass, big bluestem, and Maximilian sunflower are removed from the plant community as a result of heavy grazing by livestock. These plants are replaced by vine-mesquite, silver bluestem, and tall dropseed. If heavy grazing continues for many years, buffalograss, Texas wintergrass, and mesquite dominate the site.

In many areas lack of a seed source is a problem. Recovery of deteriorated range is slow because fertility is very low in the gullied areas. Brush generally is a minor problem. In most areas there is only a scattering of desert willow and mesquite. Important management practices include reseeding and deferred grazing.

**Gravelly Redland range site.** The Rumple soils (RUD) make up this range site.

The potential plant community is an open savannah of post oak and blackjack oak, which shade about 10 percent of the ground. The plant community is about 90 percent grasses, 5 percent woody plants, and 5 percent forbs.

Typically, the dominant plants are little bluestem, making up 25 percent of the plant community; sideoats grama, 25 percent; indiangrass, 5 percent; Arizona cottontop, pinhole bluestem, and silver bluestem, 15 percent; Canada wildrye, Texas cupgrass, and plains lovegrass, 10 percent; other mid grasses such as buffalograss, curlymesquite, Texas wintergrass, and meadow dropseed, 10 percent. Woody species such as live oak make up about 5 percent, and forbs such as bundleflower, western indigo, and gayfeather make up 5 percent.

Little bluestem, sideoats grama, wildrye, and plants such as daleas are removed from the plant community as a result of heavy grazing by livestock. These plants are replaced by curlymesquite, buffalograss, and Texas wintergrass. If heavy grazing continues for many years, threeawn, red grama, Texas grama, hairy tridens, and woody plants such as mesquite, catclaw, persimmon, and agarita dominate the site.

**Loamy Bottomland range site.** The soils making up this range site are Boerne soils (BoB), Oakalla soils (Oa, Ok), and Orif soils (Or).

The potential plant community is a savannah. Oak, pecan, hackberry, elm, cottonwood, sycamore, and other woody plants shade about 30 percent of the ground. Typically, Virginia wildrye and sedges make up 25 percent of the plant community; rustyseed paspalum and beaked panicum, 15 percent; switchgrass, indiangrass,

big bluestem, and little bluestem, 15 percent; white tridens and knotroot bristlegrass, 10 percent; eastern gamagrass, 5 percent; uniola, 5 percent; woody plants such as pecan, oak, hackberry, elm, cottonwood and sycamore, greenbrier, Alabama supplejack, and legumes, 25 percent.

This site is a preferred grazing area. Plants such as big bluestem, little bluestem, eastern gamagrass, and other nutritious forage plants are removed from the plant community as a result of overgrazing by livestock and are replaced by trees, shrubs, and woody vines. As the overstory continues to close in, production of grasses and forbs is reduced. If the rangeland is allowed to deteriorate, broomsedges and bushy bluestem, vaseygrass, cocklebur, sumpweed, osageorange, and other woody plants dominate the site.

Extensive shading by trees and bushy plants such as greenbrier and low-growing elm, ash, and sycamore is a problem on this site. Brush control is necessary in many places to improve the stand of grasses, and deferred grazing can improve the composition of the plant population.

Brush invades this site quickly if it is not properly managed. Agarita and persimmon, mixed with some Ashe juniper, elm, and shin oak, form dense thickets that large animals cannot penetrate. Brush control and rotation grazing are particularly important on this site.

**Low Stony Hills range site.** The soils making up this range site are Comfort soils (BtD, CrD, RcD, RUD) and Eckrant soils (MEC).

The potential plant community is a live oak savannah. Typically, little bluestem makes up 50 percent of the plant community; indiangrass and big bluestem, 20 percent; other mid grasses, such as wildrye, sideoats grama, Texas cupgrass, plains lovegrass, green sprangletop, dropseed, silver bluestem, vine-mesquite, buffalograss, sedges, Texas wintergrass, and perennial threeawn, 15 percent; woody plants, such as live oak, elm, and hackberry, 10 percent; and forbs, such as orange zexmenia, bushsunflower, bundleflower, prairie-clover, milk pea, snapbean, and Engelmann-daisy, 5 percent.

Little bluestem, indiangrass, and big bluestem are removed from the plant community as a result of excessive grazing by livestock and wild animals and are replaced by sideoats grama, Texas wintergrass, buffalograss, and silver bluestem. If heavy grazing continues, the replacement plants disappear. Texas wintergrass and buffalograss can best withstand overgrazing and generally are the last to disappear. If the range is allowed to deteriorate, Ashe juniper, agarita, mesquite, Texas persimmon, pricklypear, tasajillo, prairie coneflower, broomweed, burclover, plantains, hairy tridens, Texas grama, and annual grasses and forbs can dominate the site.

**Redland range site.** The Tarpley soils (TaB) make up this range site.

The potential plant community is about 90 percent tall and mid grasses. The rest is mostly trees and forbs.

Typically, little bluestem makes up 50 percent of the plant community; indiangrass, 15 percent; big bluestem and wildrye, 15 percent; other mid grasses such as sideoats grama, dropseed, silver bluestem, Texas cupgrass, Texas wintergrass, wildrye, buffalograss, vine-mesquite, and perennial threeawn, 10 percent. Woody species such as post oak, live oak, and elm make up about 5 percent, and forbs such as wild bean, Engelmann-daisy, gayfeather, bundleflower, sensitivebrier, and vetch make up 5 percent.

Little bluestem, big bluestem, indiangrass, wildrye, and Engelmann-daisy are removed from the plant community as a result of heavy grazing by livestock and are replaced by sideoats grama, buffalograss, Texas wintergrass, and vine-mesquite. If heavy grazing continues for many years, woody plants such as live oak, post oak, and elm increase, and an understory of plants such as dropseed, sedges, and perennial threeawn forms. Eventually, after continued abuse, invaders such as coneflower, broomweed, Ashe juniper, and mesquite dominate.

The forage on this site is more nutritious than that on most of the adjoining sites and is preferred by domestic animals. Controlling invading mesquite, persimmon, and agarita and maintaining the quality and quantity of forage is a problem. Seasonal and deferred grazing are important management practices.

**Shallow range site.** The soils making up this range site are Doss soils (DoC, RcD), Gruene soils (GrC), and Purves soils (PuC).

The potential plant community is grassland and scattered motts of live oak. Typically, little bluestem makes up 25 percent of the plant community; sideoats grama, 30 percent; other mid grasses, such as silver bluestem, green sprangletop, Texas wintergrass, wildrye, curlymesquite, buffalograss, and perennial threeawn, 35 percent; woody plants, such as live oak, kidneywood, and elbowbush, 5 percent; and forbs such as Engelmann-daisy, bundleflower, neptunia, bushsunflower, and gayfeather, 5 percent.

If the range is overgrazed, little bluestem and sideoats grama are removed from the plant community and are replaced by curlymesquite, buffalograss, Texas wintergrass, silver bluestem, and green sprangletop. Woody plants such as live oak and Ashe juniper increase if heavy grazing continues. If the range becomes extremely deteriorated, broomweed, threeawn, and annual grasses and forbs invade.

Encroachment of Ashe juniper, persimmon, agarita, condalia, and mesquite is a problem. Brush control and rotation grazing are important management practices.

**Steep Adobe range site.** The soils making up this range site are Brackett soils (BtG) and Real soils (BtG).

Grasses make up about 75 percent of the potential plant community. Woody plants and forbs make up the rest.

Typically, little bluestem makes up 40 percent of the plant community; indiangrass, 5 percent; sideoats grama and tall grama, 15 percent; other mid grasses such as muhlys, green sprangletop, dropseed, hairy grama, perennial threeawn, tridens, and sedges, 15 percent. Woody plants, such as live oak and Texas oak, make up about 15 percent; and forbs, such as orange zexmenia, prairie-clover, daleas, and vetch, make up about 10 percent.

Little bluestem, indiangrass, and sideoats grama are removed from the plant community as a result of overgrazing and are replaced by hairy grama, green sprangletop, tridens, perennial threeawn, and orange zexmenia. If heavy grazing continues for many years, woody plants such as Ashe juniper increase significantly. If the range is allowed to deteriorate, Texas grama, red grama, hairy tridens, tumblegrass, poverty dropseed, and queensdelight are dominant on this site.

Most areas of this site presently are covered with Ashe juniper and other brush. Even where the brush is cleared, the quality and quantity of forage are low, and there is little incentive to improve this site for domestic use. Steep slopes and outcrops of rock are additional limitations. This site generally is better suited to use as habitat for wildlife than to use as rangeland.

**Steep Rocky range site.** The Eckrant soils (ErG, MED) make up this range site.

The potential plant community is live oak and Texas oak savannah. It is 75 percent, by weight, grasses, 10 percent forbs, and 15 percent woody plants.

Little bluestem makes up 40 percent of the plant community; sideoats grama, 10 percent; other grasses, such as indiangrass, big bluestem, Texas cupgrass, cane and pinhole bluestem, tall grama, purple threeawn, plains lovegrass, and green sprangletop, 25 percent; woody plants, such as live oak, Texas oak, sumac, Texas madrone, 15 percent; and forbs, such as Engelmann-daisy, bushsunflower, and bundleflower, 10 percent.

Little bluestem, indiangrass, and Engelmann-daisy are the preferred plants. These plants are removed from the plant community as a result of heavy grazing and are replaced mainly by sideoats grama, pinhole bluestem, and live oak. If heavy grazing continues for many years, woody plants such as the oaks form a dense stand that has an understory of plants such as threeawn, Texas wintergrass, slim tridens, Ashe juniper, and Texas persimmon.

In most areas, this site is dominated by invaders such as Ashe juniper, Mexican buckeye, persimmon, and agarita and a scattering of live oak and Texas oak. It has remained in brush because of the cost of brush removal. Furthermore, steep slopes and an extremely stony surface inhibit grazing by livestock.

**Tight Sandy Loam range site.** The Pedernales soils (PdB) make up this range site.

The potential plant community is a tall grass, post oak savannah. The composition, by weight, is about 85 percent grasses, 10 percent woody plants, and 5 percent forbs.

Typically, sideoats grama makes up 20 percent of the plant community; little bluestem, 20 percent; indiangrass, 5 percent; pinhole bluestem and Arizona cottontop, 15 percent; vine-mesquite, 10 percent; wildrye, 10 percent; Texas wintergrass, paspalums, and panicums, 5 percent; woody plants such as live oak and post oak, and forbs such as Engelmann-daisy, snoutbean, orange zexmenia, and bushsunflower, 15 percent.

Little bluestem, indiangrass, wildrye, sideoats grama, and palatable forbs are grazed out of the plant community with continuous heavy grazing by livestock. These plants are replaced by buffalograss, paspalums, hairy grama, and hooded windmillgrass. Also, a variety of woody plants, such as agarita, persimmon, mesquite, and lotebush, and cactus begin to take over.

In a deteriorated condition, a heavy woody canopy and an understory of plants such as red lovegrass, tumblegrass, baccharis, broomsedge bluestem, ragweed, and bitterweed dominate the site.

## recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example,

interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

*Camp areas* require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

*Golf fairways* are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

## wildlife habitat

Dalton Merz, range conservationist, Soil Conservation Service, prepared this section.

Comal and Hays Counties provide habitat for a plentiful and varied wildlife population. The principal species are deer, turkey, squirrel, bobwhite quail, dove, rabbit, and many nongame birds and animals. Furbearing species include fox, raccoon, ringtail cat, skunk, opossum, bobcat, beaver, nutria, and coyote. Several exotic big game species, for example, axis deer, sika deer, fallow deer, red deer, black buck, barbados sheep, and mouflon sheep, have been introduced into the survey area by ranchers.

Fish and waterfowl are also resources of economic importance. Approximately 8,398 acres in the survey area is inland water. Water is impounded in Canyon Lake and elsewhere by flood retarding structures built by the Soil Conservation Service. These water areas, as well as numerous farm and ranch ponds and many streams and rivers, are used by migrating ducks and geese. Most of the ponds are stocked with fish, and all of the lakes and rivers provide fishing. Black and white bass, channel and yellow catfish, crappie, and sunfish are important fish species. Rainbow trout are stocked and harvested in the Guadalupe River below Canyon Lake.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

*Grain and seed crops* are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and

seed crops are corn, wheat, oats, grain sorghum, and sunflowers.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are clover, vetch, switchgrass, kleingrass, wildrye, and johnsongrass.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western ragweed, croton, panicums, sunflowers, and Texas needlegrass.

*Shrubs* are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are agarita, elbow bush, Texas colubrina, skunkbush, greenbrier, chokecherry, and kidneywood.

*Wetland plants* are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

*Shallow water areas* have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

*Habitat for openland wildlife* consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, dove, meadowlark, field sparrow, cottontail, and fox.

*Habitat for wetland wildlife* consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

*Habitat for rangeland wildlife* consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include white-tailed deer, jackrabbit, coyote, bobcat, and wild turkey.

## engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

*Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.*

*The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and

topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

## building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

*Dwellings and small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

## sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

*Septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site

features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

*Sewage lagoons* are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

*Daily cover for landfill* is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

## construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

*Roadfill* is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil

after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

*Sand and gravel* are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as caliche, marl, shale, and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

## water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil

material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*Drainage* is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; and susceptibility to flooding. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

*Irrigation* is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

*Terraces and diversions* are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

*Grassed waterways* are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

## gardening and landscaping

A knowledge of the soils and their properties is helpful in selecting flowers, ground cover, vines, shrubs, and trees that are suited to an area. In some areas, plants that are used for esthetic purposes may also be helpful in controlling erosion.

Soils that are well suited to yard and garden plants are those that have a deep root zone, a loamy texture, a balanced supply of plant nutrients, plenty of organic matter in various stages of decomposition, an adequate available water capacity, good drainage, and granular structure that allows free movement of water, air, and roots. The degree of acidity or alkalinity suitable for the particular plants to be grown is also important. For example, roses and most annual flowers, most vegetables, and most grasses generally grow best in soils that are neutral or slightly acid. Azaleas, camellias, and similar plants need acid soils. If some plants are grown in soils that have a high content of lime, they develop a condition called chlorosis, a yellowing of the leaves. Many flowers, shrubs, and trees, however, grow well on limy (calcareous) soils. Shasta daisies, hollyhocks, petunias, zinnias, gladiolus, crapemyrtle, pecan, and fruitless mulberry are some of the flowers, shrubs, and trees that grow well on limy soils. Many plants and trees native to the survey area are well suited to use in landscaping, including live oak, Spanish oak, sycamore, poplar, pecan, baldcypress, mountain laurel, lantana, yaupon, wild plum, yucca, Lindheimer silk-tassel, redbud, and evergreen sumac.

It is generally less expensive to condition the native soil than to replace it with an artificially prepared soil mixture. The soil should be tested and fertility needs determined for the plants to be grown. The most important addition the soil generally needs is organic matter. The organic matter can be cotton burs, peat moss, compost, rotted sawdust, or manure.

In some areas the soils are so shallow or stony that it may be necessary to construct raised beds for growing flowers and some shrubs. Brick, tile, metal, cedar, and redwood make good retainers for flowerbeds. Beds should be filled with good soil that is well balanced physically and chemically.

All plants, whether grown in native soil or introduced soil, require careful maintenance, especially during the period of establishment. Good management practices include fertilizing, watering, weed control, and insect control. The potential of the native soil for plants should be considered when selecting sites for urban construction, and existing trees should be protected during construction. Large, healthy trees are a valuable asset to the property and can be worked into the landscaping plan.

## town and country planning

Residential subdivision development and the accompanying extension of public utilities create a need for different information about soils than that needed for farming. Many people, those who are building summer houses or recreation facilities, for example, need soils information about individual residential tracts that are outside the range of public utilities.

Land appraisers, realtors, city planners, builders, and individuals need to have facts that help them know what sites are suitable for homes or other buildings and what areas are more suitable for other uses. Most soil properties that are important for town and country planning are also important for engineering. The information in the "Engineering" and "Engineering index properties" sections of this soil survey does not, however, eliminate the need for more detailed onsite studies if the soils are to be used intensively. Most mapped areas of soils contain areas of contrasting soils that are too small to be shown separately on the soil map.

In this section, site selection, foundations, sewage disposal systems, underground utility lines, erosion and runoff, and public health are discussed in terms of their effect on urban and residential development.

### site selection

When a site is selected for the construction of urban works and structures, the soil at the site should be carefully studied. Lack of information about the soils can result in costly failures. If a soil is poorly suited to an intended use, changing it can be expensive. In some instances a structure can be designed to overcome the limitations of the soil, if these limitations are recognized prior to construction.

A primary consideration in choosing a site is the hazard of flooding. Oakalla, Orif, and Tinn soils, for example, are subject to occasional or frequent flooding and are therefore severely limited as sites for permanent structures. These soils are better suited to use as greenbelts, sound barriers, wildlife habitat, hiking trails, bike trails, and picnic areas.

Other soil features that affect site selection are permeability, available water capacity, drainage, reaction (pH), corrosivity to steel and concrete, and hydrologic classification.

### foundations

Certain types of soils require special attention if they are to be used as a site for buildings. In some parts of the survey area the soils are clayey and have a high content of montmorillonite. These soils swell when wet and shrink and crack as they dry, creating enough pressure to crack walls and foundations that are not properly designed and installed.

Foundations on Anhalt, Branyon, Ferris, Heiden, Houston Black, and Medlin soils are most susceptible to damage from shrinking and swelling. Denton, Krum, and Tinn soils also have a high content of montmorillonitic clay. Soils likely to swell and shrink enough to damage foundations are those that have a high liquid limit and high plasticity index and are classified as CH in the Unified system of classification (see tables 9 and 13). Soils that are subject to flooding or have low strength or high corrosivity should also be given special attention.

### sewage disposal systems

Many new houses are being built in areas beyond municipal sewerlines. These houses must have onsite sewage disposal systems. The effectiveness of these systems depends largely on the absorptive capacity and permeability of the soils in the filter field and on the percolation rate, wetness, hazard of flooding, seepage, and slope.

The soils of Comal and Hays Counties generally have severe limitations as sites for septic tank absorption fields. Some of the soils in the survey area are clayey and consequently are very slowly permeable. Others are shallow to bedrock.

By using the general soil map to identify the soils and by referring to the ratings in table 10, a user of this soil survey can get a general idea of how well a septic tank system functions in a selected area. Nevertheless, a detailed inspection of the soils should be made at the exact site that is to be used as a filter field.

### underground utility lines

Water mains, gas pipelines, communication lines, and sewer pipes buried in the soil can corrode and break unless protected against electrobiochemical reactions resulting from the inherent properties of the soil.

All metals corrode to some degree if they are buried in soil. Some metals corrode more rapidly than others. The corrosion potential depends on the physical, chemical, electrical, and biological characteristics of the soil. For example, the amount of oxygen or of anaerobic bacteria, the moisture content, and external factors such as manmade electrical currents can influence the corrosion potential. Corrosion is greatest where two dissimilar metals are connected, where metal structures are buried at varying depths, and where pipelines extend through different kinds of soils.

Measurements of electrical resistivity of a soil indicate probable corrosion potential. Electrical resistivity is the resistance of the soil to the flow of an electrical current when the soil is wetted to field capacity. It is measured in ohms per cubic centimeter. A low value indicates low resistance (or high conductivity) and high corrosion potential.

In soils that have a high shrink-swell potential (see table 14), the stress created by changes in volume can

cause cast-iron pipe to break. To prevent breakage, pipes should be cushioned with sand.

### control of runoff and erosion

During construction, the natural vegetation is generally removed, and the soil is covered with impervious pavement, concrete, or buildings. Consequently, runoff in urban areas is generally greater than in areas where the soils are in other uses. Runoff after a heavy rain in an urban area can be several times more than in an area where the soil is used for farming. The runoff concentrates in streets and gutters, instead of flowing into natural waterways, resulting in flooding, erosion, and deposition of sediment in lower lying areas. Careful planning can prevent or reduce the problems caused by erosion, runoff, and sedimentation.

### public health

Soils provide sites for sewage disposal and for sanitary landfills. Such areas, as well as some naturally wet areas, can be breeding grounds for disease-carrying insects.

Sewerlines, septic tank systems, and sewage lagoons should be constructed so that seepage or drainage cannot pollute water supplies. The stability of the soil needs to be considered in locating sewage lines. If the gradeline is interrupted, the sewage system breaks down, creating a hazard to the public health. Tables 14 and 15 provide information on shrink-swell potential, corrosion potential, and volumetric shrinkage that can be helpful in selecting suitable soils for pipelines. Water wells, streams, and lakes can become contaminated by runoff from clogged filter fields, and rapid percolation of septic tank effluent can result in the pollution of underground water. Seepage from sewage lagoons built on unsuitable soil material can be a source of pollution. Table 10 provides information on the suitability of the soils as sites for septic tank absorption fields and sewage lagoons.

# soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

## engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

*Classification* of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

## physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

*Permeability* refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

*Available water capacity* refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

*Soil reaction* is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*Depth to bedrock* is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

*Cemented pans* are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

## engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Texas State Department of Highways and Public Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO),

D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Specific gravity (Particle index), Method A—T 100 (AASHTO), D 653 (ASTM); California bearing ratio—T 193 (AASHTO), D 1883 (ASTM); Shrinkage—T 92 (AASHTO), D 427 (ASTM); Limestone bearing ratio—Florida Highway Standard; Volume change (Abercrombie)—Georgia Highway Standard.

# classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Vertisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustert (*Ust*, meaning burnt, plus *ert*, from Vertisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Chromustert (*Chrom*, meaning color, plus *ustert*, the suborder of the Vertisols that have light colors).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that receives more moisture than is typical of the great group. An example is Udic Chromosterts.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, thermic Udic Chromusterts.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series. An example is the Heiden series.

## soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*6*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*7*). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

### Altoga series

The Altoga series consists of deep, well drained, gently sloping to sloping clayey soils on uplands. The soils formed in calcareous clayey sediment. Slopes range from 2 to 8 percent.

Typical pedon of Altoga silty clay, 2 to 5 percent slopes, eroded; from the intersection of U.S. Interstate 35 and Farm Road 725 in New Braunfels, 1 mile south on Farm Road 725, 0.9 mile west on county line road, and 300 feet north of road, in a pasture:

A1—0 to 7 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; extremely hard, very firm; many fine roots; many wormcasts; calcareous; moderately alkaline; abrupt wavy boundary.

B2—7 to 13 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; moderate medium subangular blocky structure; very hard, very firm; common fine roots; many wormcasts; calcareous; moderately alkaline; gradual wavy boundary.

B3ca—13 to 36 inches; light gray (2.5Y 7/2) silty clay, light brownish gray (2.5Y 6/2) moist; few fine faint yellow mottles; moderate fine subangular blocky structure; very hard, firm; few fine roots; many wormcasts; few soft masses and rounded concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; white (2.5Y 8/2) silty clay, light gray (2.5Y 7/2) moist; about 15 percent yellow (2.5Y 7/6) partly weathered shaly marl; rock structure; very hard, very firm; calcareous, moderately alkaline.

The solum is 35 to 52 inches thick. The calcium carbonate equivalent in the 10- to 40-inch control section ranges from 40 to 70 percent. Silicate clay makes up 25 to 35 percent of the control section.

The A horizon is grayish brown, pale brown, light brownish gray, or light yellowish brown.

The B2 horizon and B3ca horizons are grayish brown, light brownish gray, pale brown, light gray, very pale brown, or pale yellow.

The C horizon is very pale brown, light gray, light yellowish brown, pale yellow, or white.

## Anhalt series

The Anhalt series consists of moderately deep, well drained, nearly level to gently sloping clayey soils on uplands. The soils formed in clayey residual material that weathered from hard limestone. Slopes range from 0 to 3 percent.

Typical pedon of Anhalt clay, 1 to 3 percent slopes; from the intersection of U.S. Highway 281 and Bulverde Road about 18 miles west of New Braunfels near Bulverde, 2.2 miles northwest on Bulverde Road, 6.3 miles northwest on Ammann Road, and 890 feet north, in cropland:

Ap—0 to 7 inches; dark reddish gray (5YR 4/2) clay, dark reddish brown (5YR 3/2) moist; weak coarse and medium blocky structure; very hard, very firm; common fine roots; few limestone fragments; neutral; gradual smooth boundary.

A1—7 to 23 inches; dark reddish gray (5YR 4/2) clay, dark reddish brown (5YR 3/2) moist; moderate coarse blocky structure; very hard, very firm; common fine roots mostly on faces of peds; few limestone fragments; few earthworm casts; few pressure faces; few intersecting slickensides; neutral; gradual smooth boundary.

B—23 to 32 inches; dark reddish brown (2.5YR 3/4) clay, dusky red (2.5YR 3/2) moist; moderate medium blocky structure; very hard, very firm; few limestone and chert fragments; few intersecting slickensides; few dark reddish gray streaks in filled cracks; neutral; abrupt smooth boundary.

R—32 to 35 inches; indurated fractured limestone.

The thickness of the solum and the depth to indurated limestone range from 20 to 40 inches. The soil is slightly acid to moderately alkaline throughout. Limestone and chert fragments cover 0 to 15 percent of the surface and make up as much as 15 percent of the volume. When dry, the soil has cracks 0.4 to 2 inches in width that extend from the surface to the R layer.

The A horizon is dark brown or dark reddish gray. The B horizon is reddish brown or dark reddish brown.

## Austin series

The Austin series consists of moderately deep, well drained, gently sloping clayey soils on uplands of the Blackland Prairie. The soils formed in chalk or interbedded marl and chalk. Slopes range from 1 to 5 percent.

Typical pedon of Austin silty clay in an area of Austin-Castephen complex, 1 to 3 percent slopes; from intersection of Farm Road 150 and U.S. Interstate 35 in Kyle, 2.3 miles north on Farm Road 150, 1.1 miles north on Farm Road 2770, 0.6 mile east on county road, and 1,100 feet north of road, in rangeland:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium and fine subangular blocky structure; friable, slightly hard; many fine roots; calcareous; moderately alkaline; clear smooth boundary.

B21—11 to 18 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate medium and fine subangular blocky structure; friable, slightly hard; many fine roots; few chalk fragments; calcareous; moderately alkaline; gradual smooth boundary.

B22—18 to 24 inches; pale brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) moist; moderate medium and fine subangular blocky structure; friable, slightly hard; few fine roots; few fine pores; common concretions of calcium carbonate and chalk fragments; few vertical streaks of very dark grayish brown (10YR 3/2); calcareous; moderately alkaline; abrupt smooth boundary.

Cr—24 to 34 inches; weakly cemented chalk with hardness of less than 3 by Mohs scale.

The thickness of the solum and the depth to chalk or interbedded marl and chalk range from 20 to 40 inches. The soil is silty clay or clay throughout. Clay content ranges from 35 to 55 percent. Some pedons have few chalk fragments on the surface and within the solum.

The A horizon is dark gray, very dark gray, dark grayish brown, or very dark grayish brown.

The B horizon is brown, dark yellowish brown, yellowish brown, or grayish brown. The calcium carbonate equivalent ranges from 40 to 70 percent. Silicate clay makes up 25 to about 35 percent of the volume.

## Boerne series

The Boerne series consists of deep, well drained, gently sloping loamy soils on stream terraces. The soils formed in calcareous, loamy alluvial sediment. Slopes range from 1 to 3 percent.

Typical pedon of Boerne fine sandy loam, 1 to 3 percent slopes; from the intersection of U.S. Interstate 35 and Texas 80 in San Marcos, 2.8 miles northeast on Interstate 35 and 600 feet west of access road, in a field:

Ap—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; hard, friable; many fine roots; few snail shell fragments; calcareous; moderately alkaline; abrupt smooth boundary.

A1—5 to 17 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; few snail shell fragments; calcareous; moderately alkaline; gradual smooth boundary.

B21ca—17 to 26 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; few fine roots; common fine pores; common films and threads of calcium carbonate; few snail shell fragments; few rounded pebbles 0.1 to 1 inch across in thin discontinuous strata; calcareous; moderately alkaline; gradual smooth boundary.

B22ca—26 to 41 inches; very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable; few fine roots; common fine pores; many films and threads of calcium carbonate; few rounded pebbles 0.1 to 1 inch across in discontinuous strata; calcareous; moderately alkaline; gradual smooth boundary.

Cca—41 to 65 inches; very pale brown (10YR 7/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; few fine roots; many films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum is 36 to about 80 inches thick. The calcium carbonate equivalent in the 10- to 40-inch control section ranges from 40 to 75 percent.

The A horizon is brown, grayish brown, or light brownish gray.

The B horizon is brown, pale brown, very pale brown, or light yellowish brown. It is fine sandy loam or loam. In some pedons, it has strata of very fine sandy loam or sandy clay loam. Silicate clay makes up about 10 to 18 percent of the volume. Water-worn limestone pebbles are concentrated in thin discontinuous strata and make up less than 15 percent of the volume.

## Bolar series

The Bolar series consists of moderately deep, well drained, gently sloping loamy soils on uplands. These soils formed in loamy sediment over interbedded limestone and marl. Slopes commonly range from 1 to 3 percent.

Typical pedon of Bolar clay loam, 1 to 3 percent slopes; from the intersection of Ranch Road 12 and Ranch Road 2325 in Wimberly, 4 miles north on Ranch Road 12, 0.2 mile east on county road, and 250 feet south of road, in rangeland:

A11—0 to 5 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, firm; common fine roots; many limestone fragments less than 0.1 inch across and few fragments 0.1 to 0.5 inch across; few earthworm casts; calcareous; moderately alkaline; clear smooth boundary.

A12—5 to 14 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky and granular; hard, firm; common fine roots; many limestone fragments less than 0.1 inch across and few fragments 0.1 to 0.5 inch across; few earthworm casts; calcareous; moderately alkaline; gradual smooth boundary.

B2ca—14 to 28 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; many limestone fragments less than 0.1 inch across and few fragments 0.1 to 2 inches across; few small snail shell fragments; common weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

R—28 to 30 inches; indurated limestone that is fractured and interbedded with clayey marl.

The solum is 25 to 40 inches thick. The calcic horizon is at a depth of 12 to 24 inches. The calcium carbonate equivalent in the 10- to 40-inch control section ranges

from 40 to 60 percent. Silicate clay makes up 20 to 35 percent of the control section.

The A horizon is brown, dark brown, very dark brown, or dark grayish brown.

The B horizon is light brown, brown, or yellowish brown. Coarse fragments of limestone as much as 4 inches across make up 1 to 20 percent of the volume. Concretions of calcium carbonate range from few to common.

## Brackett series

The Brackett series consists of shallow, well drained, undulating to steep loamy soils on uplands (fig. 13). The soils formed in interbedded soft limestone and marl. Slopes range from 1 to 30 percent.

Typical pedon of Brackett gravelly clay loam, in an area of Brackett-Rock outcrop-Real complex, steep; from the intersection of Ranch Road 32 and Ranch Road 12 about 10 miles west of San Marcos, 6 miles west on Ranch Road 32 and 1,000 feet north of the road, in rangeland:

A1—0 to 6 inches; grayish brown (10YR 5/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky and granular structure; hard, friable; common fine roots; about 15 percent, by volume, weakly cemented limestone pebbles as much as 1 inch across; calcareous; moderately alkaline; clear smooth boundary.

B2—6 to 14 inches; light gray (10YR 7/2) gravelly clay loam, light brownish gray (10YR 6/2) moist; moderate fine subangular blocky and granular structure; hard, friable; common fine roots; about 20 percent, by volume, weakly cemented limestone pebbles as much as 1 inch across; calcareous; moderately alkaline; clear wavy boundary.

Cr—14 to 18 inches; weakly cemented limestone interbedded with thin strata of pale yellow and very pale brown calcareous shaly clay.

The solum is 11 to 20 inches thick. Coarse fragments make up as much as 35 percent of the volume. They are mostly pebbles, but as much as 10 percent is cobbles and stones. The calcium carbonate equivalent ranges from 40 to more than 80 percent.

The A horizon is grayish brown, pale brown, brown, very pale brown, and light gray. It is gravelly loam or gravelly clay loam.

The B horizon is pale brown, very pale brown, light yellowish brown, light brownish gray, or light gray. It is gravelly loam or gravelly clay loam.

The Cr horizon is pale yellow, very pale brown, or white. It is thinly interbedded marly earth, weakly cemented limestone, and calcareous shaly clay.

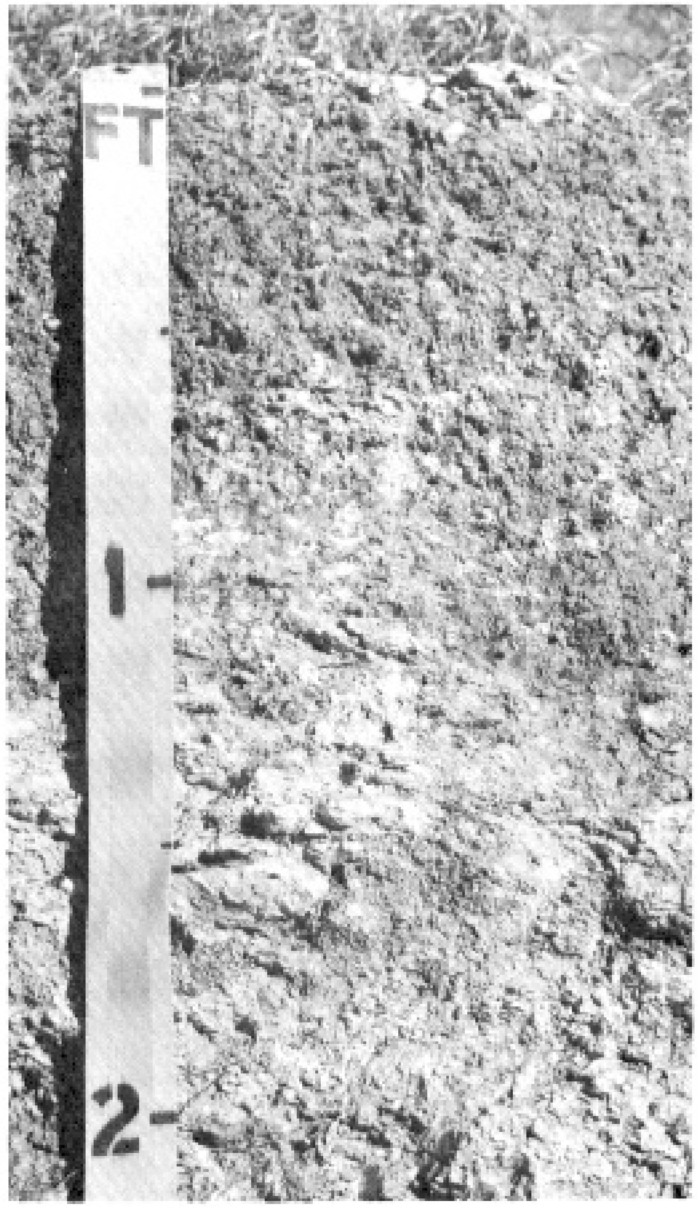


**Figure 13.—Typical profile of Brackett gravelly clay loam. Interbedded soft limestone and marl are at a depth of about 14 inches.**

## Branyon series

The Branyon series consists of deep, moderately well drained, nearly level to gently sloping clayey soils on broad ancient stream terraces. The soils formed in calcareous clayey sediment. Slopes range from 0 to 3 percent.

Typical pedon of Branyon clay, 0 to 1 percent slopes; from the intersection of Texas 80 and Texas 21 in San

Marcos, 4.3 miles northeast on Texas 21, 1.1 mile northwest on county road, 0.7 mile northeast on county road, and 1,900 feet southeast, in cropland:

Ap—0 to 6 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium and fine blocky structure; extremely hard, very firm; few fine roots; calcareous; moderately alkaline; clear smooth boundary.

A11—6 to 32 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium blocky structure; extremely hard, very firm; few fine roots; common intersecting slickensides; calcareous; moderately alkaline; gradual smooth boundary.

A12—32 to 44 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium blocky structure; extremely hard, very firm; many intersecting slickensides; few concretions of calcium carbonate; few brownish yellow wormcasts; calcareous; moderately alkaline; gradual wavy boundary.

AC1—44 to 54 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; extremely hard, very firm; common intersecting slickensides; common concretions of calcium carbonate; few brownish yellow wormcasts; few thin dark gray streaks from the upper horizons; calcareous; moderately alkaline; gradual wavy boundary.

AC2—54 to 60 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium blocky structure; extremely hard, very firm; common intersecting slickensides; many concretions and soft masses of calcium carbonate; few brownish yellow wormcasts; few thin dark gray streaks from the upper horizons; calcareous; moderately alkaline; clear wavy boundary.

C—60 to 80 inches; faintly mottled very pale brown (10YR 7/4) and pale yellow (2.5Y 8/4) clay; massive; extremely hard, very firm; many soft masses of calcium carbonate; calcareous; moderately alkaline.

The solum is 50 to 70 inches thick in the microdepressions. Microdepressions make up 75 to 90 percent of each pedon. When the soil is dry, cracks 1 to 3 inches wide extend from the surface to a depth of 20 to 60 inches or more.

The A horizon is gray or dark gray. It is 15 to 50 inches thick in the microdepressions, which make up about 85 percent of the pedon. In more than half the pedons, the A horizon is more than 38 inches thick. It is 3 to 15 inches thick on the microknolls.

The AC horizon is brown, grayish brown, yellowish brown, light yellowish brown, or gray. In some pedons, the soil is noncalcareous to a depth of 18 inches in microdepressions. In other pedons there is a IIC horizon of gravelly clay below a depth of 50 inches.

## Castephen series

The Castephen series consists of shallow, well drained, gently sloping loamy and clayey soils on uplands. The soils formed in residuum of chalk and marl. Slopes range from 1 to 5 percent.

Typical pedon of Castephen clay loam, 3 to 5 percent slopes, eroded; from the intersection of Farm Road 150 and U.S. Interstate 35 in Kyle, 2.3 miles northwest on Farm Road 150, 0.4 mile southwest on county road, 0.3 mile west on private road, and 85 feet south of road, in rangeland:

A11—0 to 8 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; few chalk fragments less than 0.1 inch across; calcareous; moderately alkaline; clear smooth boundary.

A12—8 to 13 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; few chalk fragments less than 1 inch across; calcareous; moderately alkaline; clear wavy boundary.

A13—13 to 16 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; about 50 percent, by volume, weakly cemented chalk fragments as much as 2 inches across; calcareous; moderately alkaline; abrupt wavy boundary.

Cr—16 to 20 inches; white weakly cemented platy chalk.

The solum is 8 to 20 inches thick. The calcium carbonate equivalent averages 40 to about 60 percent. Silicate clay makes up 25 to 35 percent of the volume.

The A horizon is brown, dark brown, dark gray, very dark gray, grayish brown, dark grayish brown, or very dark grayish brown. It is clay loam, silty clay loam, or silty clay. Chalk fragments less than 3 inches across make up 10 to 35 percent of the volume. The percentage increases with depth.

## Comfort series

The Comfort series consists of shallow, well drained, undulating clayey soils on uplands. These soils formed in clay that weathered from dolomitic limestone. Slopes range from 1 to 8 percent.

Typical pedon of Comfort extremely stony clay, in an area of Comfort-Rock outcrop complex, undulating; from the intersection of Farm Road 306 and Farm Road 464 about 21 miles northwest of New Braunfels near Canyon

Lake, 9.3 miles west on Farm Road 306 and 50 feet north of road, in rangeland:

A1—0 to 6 inches; dark brown (7.5YR 3/2) extremely stony clay, dark brown (7.5YR 3/2) moist; moderate medium blocky structure parting to moderate fine blocky; very hard, very firm; many fine roots; about 45 percent, by volume, cobbles and stones as much as 4 feet across on the surface and in the soil; noncalcareous; mildly alkaline; clear smooth boundary.

B2t—6 to 13 inches; dark reddish brown (5YR 3/2) extremely stony clay, dark reddish brown (5YR 3/2) moist; moderate fine blocky structure parting to moderate very fine blocky; very hard, very firm; common fine roots; patchy clay films on ped faces; about 70 percent, by volume, stones as much as 4 feet across; noncalcareous; mildly alkaline; abrupt irregular boundary.

R—13 to 20 inches; indurated dolomitic limestone; soil material in the narrow fractures.

The solum is 9 to 20 inches thick. Soil reaction ranges from neutral to moderately alkaline. Stones, cobbles, and pebbles make up 35 to 60 percent of the volume. The cobbles and stones are dolomitic limestone, and the pebbles are dominantly chert.

The A horizon is dark brown or dark reddish brown. The fine-earth fraction is clay or clay loam.

The B2t horizon is dark reddish brown or red.

## Denton series

The Denton series consists of moderately deep, well drained, gently sloping clayey soils on uplands. The soils formed in calcareous clays over indurated limestone. Slopes range from 1 to 5 percent.

Typical pedon of Denton silty clay, 1 to 3 percent slopes; from the intersection of Farm Road 150 and Farm Road 1826 near Driftwood, 0.6 mile south on Farm Road 1826, 0.2 mile west on county road, and 1,000 feet southeast of road, in pasture:

A11—0 to 14 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine granular and moderate medium subangular blocky structure; very hard, firm; many fine roots; calcareous; moderately alkaline; gradual smooth boundary.

A12—14 to 25 inches; dark brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate medium subangular blocky and blocky structure; very hard, firm; common fine roots; few concretions of calcium carbonate; few limestone pebbles less than 0.2 inch across; few small slickensides; dark grayish brown streaks in filled cracks; calcareous; moderately alkaline; gradual smooth boundary.

B2ca—25 to 33 inches; light yellowish brown (10YR 6/4) silty clay, yellowish brown (10YR 5/4) moist; moderate medium blocky and subangular blocky structure; very hard, firm; few fine roots; common concretions of calcium carbonate; dark grayish brown streaks in filled cracks; calcareous; moderately alkaline; clear wavy boundary.

Cca—33 to 36 inches; coarsely mottled light brown (7.5YR 6/4) and reddish yellow (7.5YR 6/6) silty clay, brown (7.5YR 5/4) and strong brown (7.5YR 5/6) moist; structureless; very hard, very firm; few fine roots; many concretions and soft masses of calcium carbonate; many limestone pebbles 0.5 to 1 inch across; calcareous; moderately alkaline; abrupt smooth boundary.

R—36 to 40 inches; fractured limestone that cannot be cut with a spade interbedded with calcareous clayey marl.

The solum is 24 to 40 inches thick. The mollic epipedon is 18 to 30 inches thick. When dry these soils have cracks 1 cm or more wide in the upper part of the subsoil.

The A horizon is brown, dark brown, or dark grayish brown. Fragments of limestone smaller than 3 inches across make up 0 to 5 percent of the volume.

The B horizon is light brown, brown, dark brown, or yellowish brown. Fragments of limestone smaller than 3 inches across make up 0 to 20 percent of the volume.

The Cca horizon is brown, dark brown, or reddish yellow. Limestone fragments smaller than 6 inches across make up as much as 60 percent of the volume. Some pedons do not have a Cca horizon. The R horizon ranges from indurated fractured limestone to beds of limestone rubble with clayey marl filling the interstices.

## Doss series

The Doss series consists of shallow, well drained, gently sloping to sloping loamy soils on uplands. The soils formed in interbedded marl and limestone. Slopes range from 1 to 8 percent.

Typical pedon of Doss silty clay, 1 to 5 percent slopes; from the intersection of Ranch Road 12 and Farm Road 2325 in Wimberley, 9 miles north on Ranch Road 12, 2.8 miles west on county road (Gatlin Road), and 120 feet south of road, in pasture:

A1—0 to 9 inches; dark grayish brown (10YR 4/2) silty clay, dark brown (10YR 3/2) moist; moderate medium subangular blocky and moderate fine granular structure; slightly hard, friable; common fine roots; few wormcasts; calcareous; moderately alkaline; clear smooth boundary.

B2ca—9 to 18 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky and moderate

fine granular structure; slightly hard, friable; common fine roots; few wormcasts; common concretions and soft bodies of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

Crca—18 to 24 inches; interbedded weakly cemented limestone and marl.

The solum is 11 to 20 inches thick. The calcium carbonate equivalent ranges from 40 to 60 percent.

The A horizon is dark grayish brown, dark brown, or brown. A few limestone pebbles and cobbles are on the surface and within the horizon in some pedons.

The B horizon is brown, yellowish brown, or light brown. Pebbles and cobbles of limestone make up 1 to 15 percent of the volume.

## Eckrant series

The Eckrant series consists of very shallow to shallow, well drained, undulating to steep clayey soils on uplands (fig. 14). The soils formed over indurated fractured limestone. Slopes range from 1 to 30 percent.

Typical pedon of Eckrant extremely stony clay, in an area of Eckrant-Rock outcrop complex, steep; from the intersection of Loop 82 and U.S. Interstate 35 in San Marcos, 0.8 mile west on Loop 82, 0.3 mile northeast on Old Post Road, 2 miles northwest on Lime Kiln Road, 4.8 miles northwest on Hilyard Road, and 1,900 feet northeast of road, in rangeland:

A11—0 to 6 inches; very dark gray (10YR 3/1) extremely stony clay, black (10YR 2/1) moist; moderate fine subangular blocky and granular structure; hard, firm; common fine roots; about 35 percent limestone fragments 4 to 12 inches across on the surface and in the soil; noncalcareous; moderately alkaline; clear smooth boundary.

A12—6 to 10 inches; very dark gray (10YR 3/1) extremely stony clay, black (10YR 2/1) moist; moderate fine subangular blocky and granular structure; hard, firm; common fine roots; about 75 percent, by volume, limestone fragments 8 to 20 inches or more across; noncalcareous; moderately alkaline; abrupt irregular boundary.

R—10 to 20 inches; indurated, fractured limestone.

The solum is 4 to 20 inches thick. Reaction ranges from neutral to moderately alkaline. Stones, cobbles, and pebbles make up 35 to 70 percent of the pedon. Most of the fragments are limestone, although some pedons have coarse fragments of chert and dolomitic limestone.

The A horizon is black, very dark gray, dark brown, dark grayish brown, or very dark grayish brown.

## Ferris series

The Ferris series consists of deep, well drained, sloping to moderately steep clayey soils on uplands. The soils formed in calcareous shaly clays and shale. Slopes range from 5 to 20 percent.

Typical pedon of Ferris clay, 5 to 20 percent slopes, severely eroded; from intersection of U.S. Interstate 35 and Texas 46 in New Braunfels, 5.9 miles north on Interstate 35, 0.8 mile southeast on East Watson Lane, and 700 feet south of lane, in pasture:

A1—0 to 12 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium and fine blocky structure; very hard, very firm; common

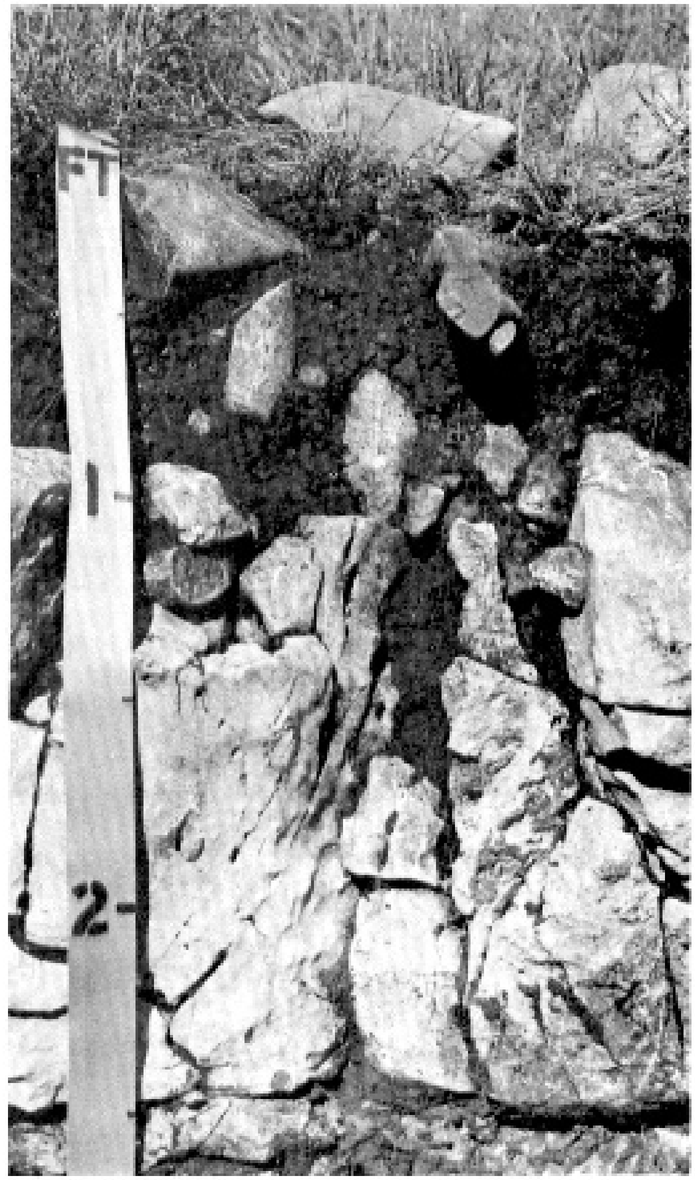


**Figure 14.—Typical profile of Eckrant extremely stony clay.**

fine roots; calcareous; moderately alkaline; clear wavy boundary.

AC1—12 to 24 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; common fine distinct mottles of pale olive (5Y 6/4) and many fine distinct mottles of light yellowish brown (2.5Y 6/4); weak coarse blocky structure; extremely hard, very firm; few fine roots; few soft masses of calcium carbonate; many intersecting slickensides; calcareous; moderately alkaline; clear smooth boundary.

AC2—24 to 35 inches; coarsely mottled light gray (10YR 6/1) and light yellowish brown (2.5Y 6/4) clay; weak coarse blocky structure; extremely hard, very firm; few fine roots; few soft masses of calcium carbonate; many intersecting slickensides; calcareous; moderately alkaline; gradual smooth boundary.

C1—35 to 41 inches; pale olive (5Y 6/3) shaly clay, olive (5Y 5/3) moist; common fine faint mottles of light yellowish brown (2.5Y 6/4) and few coarse prominent mottles of light gray (10YR 6/1); weak coarse blocky structure; extremely hard, very firm; few small masses of unweathered shale; common gypsum crystals; calcareous; moderately alkaline; clear smooth boundary.

C2—41 to 60 inches; pale yellow (2.5Y 7/4) shale, light yellowish brown (2.5Y 6/4) moist; weak coarse blocky and platy rock structure; extremely hard, very firm; calcareous; moderately alkaline.

The solum is 30 to 55 inches thick. Clay content ranges from 40 to 60 percent. Cracks more than 1 cm wide extend to a depth of more than 20 inches when the soil is dry.

The A horizon is dark grayish brown, olive gray, grayish brown, olive, light brownish gray, or pale olive. Where the moist soil has value of less than 3.5, the horizon is less than 12 inches thick.

The AC horizon is olive gray, light gray, grayish brown, light yellowish brown, pale olive, or olive yellow. Some pedons have grayish, yellowish, brownish, and olive mottles. There are gypsum crystals and soft masses of calcium carbonate in some pedons.

The C horizon is light brownish gray, pale olive, light yellowish brown, light gray, pale yellow, or yellow. It is strongly weathered shaly clay or calcareous shale.

## Gruene series

The Gruene series consists of very shallow to shallow, well drained, gently sloping clayey soils on uplands. These soils formed in clayey sediment over gravel. Slopes range from 1 to 5 percent.

Typical pedon of Gruene clay, 1 to 5 percent slopes; from the intersection of U.S. Interstate 35 and Texas 80 in San Marcos, 4.9 miles north on Interstate 35 and 550 feet east of access road at exit number 210, in pasture:

A1—0 to 13 inches; very dark grayish brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; strong coarse blocky structure breaking to moderate fine blocky; very hard, very firm; common fine roots; few chert pebbles and few limestone and chert cobbles on the surface and within the horizon; very gravelly clay layer about 2 inches thick in lower part; noncalcareous; mildly alkaline; clear wavy boundary.

Ccam—13 to 22 inches; strongly cemented, massive caliche containing embedded rounded siliceous and limestone pebbles; abrupt wavy boundary.

IIC—22 to 80 inches; stratified very pale brown (10YR 7/4) very gravelly loam becoming sandier with depth; some strata have rounded rock fragments as much as 6 inches across.

The thickness of the solum and the depth to the petrocalcic horizon is 7 to 16 inches.

The A horizon is brown, dark brown, very dark gray, or very dark grayish brown. It is 0 to 15 percent, by volume, siliceous and limestone pebbles. Its structure is blocky or subangular blocky. Reaction ranges from neutral to mildly alkaline. In some pedons the A horizon has thin, calcareous, very gravelly strata in the lower part.

The Ccam horizon is massive, strongly cemented or indurated caliche that is about 30 to 70 percent, by volume, chert and limestone. The IIC horizon is stratified very gravelly loam and sand. In some pedons it has strata of weakly cemented, nongravelly caliche.

## Heiden series

The Heiden series consists of deep, well drained, gently sloping to sloping clayey soils on uplands. The soils formed in calcareous clay and shaly clay. Slopes range from 1 to 8 percent.

Typical pedon of Heiden clay, 3 to 5 percent slopes, eroded; from the intersection of U.S. Interstate 35 and Farm Road 2001 near Buda, 1.6 miles south on Interstate 35 east access road, 0.3 mile east on county road, 0.3 mile south on county road, and 40 feet west of road, in pasture:

A1—0 to 13 inches; dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular and blocky structure; very hard, very firm; common fine roots; common earthworm casts; calcareous; moderately alkaline; gradual wavy boundary.

AC1—13 to 22 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; common dark grayish brown filled cracks; moderate medium blocky structure; very hard, very firm; common fine roots; few slickensides in lower part; calcareous; moderately alkaline; diffuse wavy boundary.

AC2—22 to 58 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; common

medium faint mottles of light olive brown (2.5Y 5/4); common cracks filled with dark grayish brown material; weak coarse blocky structure; very hard, very firm; few fine roots; common concretions and weakly cemented masses of calcium carbonate; many intersecting slickensides; calcareous; moderately alkaline; diffuse wavy boundary.

C—58 to 80 inches; pale yellow (2.5Y 7/4) shaly clay, light yellowish brown (2.5Y 6/4) moist; few fine distinct mottles of brownish yellow and common fine faint mottles of olive yellow; massive; very hard, very firm; many weakly cemented masses of calcium carbonate; calcareous; moderately alkaline.

The solum is 40 to 60 inches thick. Cracks more than 1 cm wide extend to a depth of more than 20 inches when the soil is dry.

The A horizon is grayish brown, dark grayish brown, or dark gray. It is clay or gravelly clay. It is less than 12 inches thick in pedons that are dark gray. Few to common chert pebbles are on the surface and in the soil in some pedons.

The AC horizon is grayish brown, yellowish brown, or olive. Mottles of yellow and olive are in most pedons. Gypsum crystals are few to common in some pedons.

The C horizon is light gray, light brownish gray, pale yellow, yellow, or pale olive. It is clay, shaly clay, or weathered calcareous shale.

## Houston Black series

The Houston Black series consists of deep, moderately well drained, gently sloping to sloping clayey soils on uplands. The soils formed in calcareous clay and shale. Slopes range from 1 to 8 percent.

Typical pedon of Houston Black clay, 1 to 3 percent slopes, in a microdepression; from the intersection of Farm Road 150 and U.S. Interstate 35 in Kyle, 1.6 miles north on access road, 0.4 mile southeast on county road, and 150 feet west of road, in field:

Ap—0 to 5 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine granular structure; very hard, very firm; common fine grass roots; calcareous; moderately alkaline; gradual smooth boundary.

A11—5 to 25 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate medium blocky structure; very hard, very firm; common fine roots; few snail shell fragments; calcareous; moderately alkaline; diffuse wavy boundary.

A12—25 to 50 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate medium blocky structure; very hard, very firm; few snail shell fragments, few concretions of calcium carbonate; common intersecting slickensides; few limestone pebbles as much as 1 inch across; calcareous; moderately alkaline; gradual smooth boundary.

AC1—50 to 62 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, very firm; few concretions of calcium carbonate; common intersecting slickensides; dark gray streaks in filled cracks; calcareous; moderately alkaline; gradual smooth boundary.

AC2—62 to 77 inches; grayish brown (2.5Y 5/2) and gray (10YR 5/1) clay, dark grayish brown (2.5Y 4/2) and dark gray (10YR 4/1) moist; moderate medium blocky structure; very hard, very firm; few concretions of calcium carbonate; common intersecting slickensides; dark gray streaks in filled cracks; calcareous; moderately alkaline; gradual smooth boundary.

C—77 to 90 inches; yellow (10YR 7/6) marly clay, brownish yellow (10YR 6/6) moist; massive; very hard, very firm; common soft masses of calcium carbonate; calcareous; moderately alkaline.

Combined thickness of the A and AC horizons is 60 to more than 80 inches. Cracks 0.4 inch to 4 inches wide extend to a depth of more than 20 inches when the soil is dry. Intersecting slickensides begin at a depth of about 16 to 24 inches. Clay content in the 10- to 40-inch control section ranges from 50 to 60 percent. Grayish colors that have chroma of less than 1.5 are at a depth of 30 to 60 inches in microdepressions and at a depth of 10 to 18 inches in microknolls. Cycles of microdepressions and microknolls are repeated at intervals of 10 to 24 feet. Siliceous pebbles cover as much as 60 percent of the surface in some pedons and make up as much as about 25 percent, by volume, of the upper 12 inches.

The A horizon is black, very dark gray, or dark gray in the upper part, and very dark gray, dark gray, or gray in the lower part. Brownish or olivish mottles or matrix colors are at a depth of 30 to 60 inches in microdepressions and at a depth of 10 to 18 inches in microknolls. The A horizon is moderately alkaline and calcareous except in some gravelly pedons where it is noncalcareous in the upper part.

The AC horizon is dark grayish brown, grayish brown, light grayish brown, yellowish brown, olive, or olive gray. Most pedons have gray, brown, olive, and yellow mottles. Siliceous pebbles make up 0 to about 5 percent of the volume.

## Krum series

The Krum series consists of deep, well drained, nearly level to gently sloping clayey soils on uplands. The soils formed in calcareous clayey sediment. Slopes range from 0 to 5 percent.

Typical pedon of Krum clay, 1 to 3 percent slopes; from the intersection of Farm Road 2439 and Ranch Road 12 in San Marcos, 5.2 miles southwest on Farm

Road 2439, 0.6 mile northwest on county road, and 400 feet southwest of road, in cropland:

Ap—0 to 4 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium subangular blocky and moderate fine granular structure; hard, firm; many fine roots; calcareous; moderately alkaline; clear smooth boundary.
A1—4 to 16 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium and fine subangular blocky structure; hard, firm; common fine roots; calcareous; moderately alkaline; gradual smooth boundary.
B21—16 to 58 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; very hard, very firm; very dark gray streaks in filled cracks; few fine roots; few concretions of calcium carbonate; few wormcasts; calcareous; moderately alkaline; diffuse smooth boundary.
B22—58 to 66 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; very hard, very firm; few concretions of calcium carbonate; few threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.
C—66 to 80 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; structureless; very hard, very firm; few concretions of calcium carbonate; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum is 40 to 70 inches thick. When the soil is dry, cracks 0.4 inch to 1.2 inches wide extend to a depth of about 24 to 48 inches. The 10- to 40-inch control section is clay or silty clay. The clay content is 40 to 60 percent.

The A horizon is dark gray, dark grayish brown, or dark brown. Where the A horizon, when moist, has value and chroma of less than 3.5, it is 14 to 36 inches thick. The upper 10 inches is noncalcareous in some pedons.

The B horizon is grayish brown, brown, or yellowish brown. Content of visible concretions and powdery bodies of calcium carbonate ranges from less than 1 percent to about 10 percent, but is more than 5 percent below a depth of 40 inches.

The C horizon is light yellowish brown, pale brown, brownish yellow, or light brown. Calcium carbonate concretions make up 2 to 20 percent of the volume.

## Lewisville series

The Lewisville series consists of deep, well drained, nearly level to gently sloping clayey soils on stream terraces. The soils formed in calcareous clayey and loamy sediment. Slopes range from 0 to 3 percent.

Typical pedon of Lewisville silty clay, 0 to 1 percent slopes; from the intersection of Texas 80 and Texas 21 near San Marcos, 1.9 miles northeast on Texas 21, 0.7 mile northwest on county road, and 100 feet northeast of county road, in cropland:

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky and granular structure; hard, friable; many fine roots; calcareous; moderately alkaline; abrupt smooth boundary.
A1—7 to 17 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky and moderate fine and very fine blocky structure; hard, friable; many fine roots; calcareous; moderately alkaline; gradual smooth boundary.
B21ca—17 to 36 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate fine subangular blocky and moderate fine blocky structure; hard, friable; few fine threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.
B22ca—36 to 54 inches; yellowish brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) moist; weak medium and fine subangular blocky structure; hard, firm; common soft masses of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.
Cca—54 to 61 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; common medium distinct mottles of reddish yellow (7.5YR 7/6) and pinkish white (7.5YR 8/2); massive; very hard, firm; many moderately and strongly cemented concretions of calcium carbonate 0.3 to 1 inch in diameter; calcareous; moderately alkaline.

The solum is 42 to about 63 inches thick. A calcic horizon is at a depth of 24 to 40 inches.

The A horizon is brown, dark grayish brown, or very dark grayish brown.

The B21ca horizon is brown, dark grayish brown, dark brown, or yellowish brown. The B22ca horizon is brown, light brown, reddish yellow, or yellowish brown. It is clay, silty clay, or silty clay loam and is 5 to 15 percent, by volume, visible secondary carbonates. Some pedons are underlain at a depth of 3 to 6 feet by sediment that is 15 to 50 percent gravel by volume.

## Medlin series

The Medlin series consists of deep, well drained, undulating to hilly clayey soils on uplands. The soils formed in calcareous clay and shale. Slopes range from 1 to 30 percent.

Typical pedon of Medlin stony clay, in an area of Medlin-Eckrant association, hilly; from the intersection of Farm Road 306 and U.S. Interstate 35 near New

Braunfels, 2.5 miles northwest on Farm Road 306, 1 mile west on county road, and 180 feet south of road, in rangeland:

A11—0 to 6 inches; grayish brown (2.5Y 5/2) stony clay, dark grayish brown (2.5Y 4/2) moist; moderate fine subangular blocky structure; very hard, firm; common fine roots; few wormcasts; few concretions of calcium carbonate; few limestone pebbles; stones on about 2 percent of the surface; calcareous; moderately alkaline; gradual smooth boundary.

A12—6 to 11 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine subangular blocky structure; very hard, firm; common fine roots; few wormcasts; few concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

AC1—11 to 32 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; few fine faint mottles of yellowish brown; moderate medium and coarse blocky structure; extremely hard, very firm; few fine roots; few grayish brown streaks in filled cracks; few concretions of calcium carbonate; few small slickensides in lower part; few small fossilized oyster shells; calcareous; moderately alkaline; gradual wavy boundary.

AC2—32 to 50 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; common medium faint mottles of light yellowish brown (2.5Y 6/4) and olive yellow (2.5Y 6/6); moderate medium and coarse blocky structure; extremely hard, very firm; few grayish brown streaks in filled cracks; common soft masses of calcium carbonate; common masses of gypsum crystals; few small slickensides; few small fossilized oyster shells; calcareous; moderately alkaline; gradual wavy boundary.

C—50 to 80 inches; light gray (2.5Y 7/2) shaly clay, light brownish gray (2.5Y 6/2) moist; common medium distinct mottles of olive yellow (2.5Y 6/6) and yellow (2.5Y 7/8); platy rock structure; extremely hard, very firm; few small fossilized oyster shells; common masses of gypsum crystals; calcareous; moderately alkaline.

The solum is 35 to 50 inches thick. Slickensides are below a depth of 15 to 24 inches. When the soil is dry, cracks 1 to 3 inches in width extend to a depth of more than 20 inches. Limestone pebbles and cobbles cover 0 to 40 percent of the surface, and stones cover 0 to 5 percent.

The A horizon is grayish brown or dark grayish brown.

The AC horizon is light yellowish brown, light olive brown, olive brown, olive yellow, or olive. Mottles in shades of gray, brown, and yellow are few to many. Concretions and soft masses of calcium carbonate make up 2 to 20 percent of the volume.

The C horizon is light gray, light brownish gray, light yellowish brown, yellow, pale yellow, olive yellow, or olive gray. Mottles in shades of gray, brown, or yellow are common to many.

## Oakalla series

The Oakalla series consists of deep, well drained, nearly level loamy soils on flood plains. The soils formed in calcareous loamy alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Oakalla silty clay loam, rarely flooded; from the intersection of Texas 80 and Interstate 35 in San Marcos, 0.5 mile east on Texas 80, 0.7 mile southwest on River Road, 0.2 mile southeast on Old Martindale Road, 0.2 mile southeast on Thompson Road, and 50 feet southwest of road, in cropland:

Ap—0 to 6 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and subangular blocky structure; very hard, firm; few fine roots; few snail shell fragments; calcareous; moderately alkaline; clear smooth boundary.

A1—6 to 31 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; very hard, firm; few fine roots; about 44 percent calcium carbonate equivalent; calcareous; moderately alkaline; diffuse smooth boundary.

B21—31 to 42 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; very hard, firm; few films and threads of calcium carbonate; about 42 percent calcium carbonate equivalent; few snail shell fragments; few wormcasts; calcareous; moderately alkaline; diffuse smooth boundary.

B22—42 to 62 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; very hard, firm; few films, threads, and concretions of calcium carbonate; few snail shell fragments; calcareous; moderately alkaline; clear smooth boundary.

C—62 to 80 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; massive; very hard, firm; few films and threads of calcium carbonate; few snail shell fragments; calcareous; moderately alkaline.

The calcium carbonate equivalent in the 10- to 40-inch control section ranges from 40 to 55 percent. The mollic epipedon is 20 to 34 inches thick. The soil throughout is silty clay, silty clay loam, loam, or clay loam. Rounded limestone pebbles make up 0 to 10 percent of the volume.

The A horizon is brown, grayish brown, dark brown, or dark grayish brown.

The B horizon is grayish brown, brown, dark brown, or light yellowish brown. Some pedons do not have a B horizon.

The C horizon is brown, yellowish brown, or light yellowish brown.

## Orif series

The Orif series consists of deep, well drained, nearly level to gently sloping loamy soils on flood plains. The soils formed in recently deposited gravelly alluvium. Slopes range from 0 to 3 percent.

Typical pedon of Orif soils, frequently flooded; from the intersection of U.S. Interstate 35 and Texas 80 in San Marcos, 1.2 miles north on U.S. Interstate access road, 0.5 mile east on county road (Uhland Road), and 500 feet south of road and 100 feet west of Blanco River channel, in rangeland:

A1—0 to 20 inches; grayish brown (10YR 5/2) very gravelly loamy sand, dark brown (10YR 4/3) moist; weak fine granular structure; slightly hard, very friable; few fine roots; about 50 percent, by volume, rounded limestone pebbles and cobbles mostly in horizontal strata; calcareous; moderately alkaline; clear wavy boundary.

IIC—20 to 60 inches; brown (10YR 5/3) very gravelly loamy sand, dark brown (10YR 4/3) moist; many strata of very gravelly sand, very gravelly sandy loam, and very dark grayish brown loam; single grained; slightly hard, very friable; about 75 percent, by volume, rounded pebbles and cobbles; calcareous; moderately alkaline.

The solum is 60 to 100 inches or more thick. Pebbles cover about 20 to 60 percent of the surface. A few cobbles and stones are on the surface in most places. Coarse fragments make up 35 to 80 percent of the 10- to 40-inch control section.

The A horizon is grayish brown, light brownish gray, or brown. It is gravelly loamy sand, gravelly loam, or gravelly sandy loam or their very gravelly analogs. Pebbles make up 20 to 60 percent of the volume, and in most pedons the horizon has a few cobbles and stones.

The C horizon is brown, pale brown, or very pale brown. It is very gravelly loamy sand or very gravelly sand. Below a depth of 20 inches there are thin, discontinuous strata of various textures ranging from loam to sand and including the gravelly, very gravelly, or extremely gravelly analogs. Some pedons have a IIAb horizon below a depth of 24 inches.

## Pedernales series

The Pedernales series consists of deep, well drained, gently sloping loamy soils on uplands. The soils formed in ancient loamy and clayey alluvium. Slopes range from 1 to 5 percent.

Typical pedon of Pedernales fine sandy loam, 1 to 5 percent slopes; from the intersection of U.S. 290 and Ranch Road 12 in Dripping Springs, 7.6 miles northwest on Ranch Road 12 to intersection with county road in Travis County, 7.3 miles northwest on county road, 0.4 mile west on private road, and 150 feet south of road, in rangeland:

A1—0 to 12 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; slightly hard, friable; many fine roots; few chert pebbles 0.2 to 0.5 inch across; neutral; clear smooth boundary.

B21t—12 to 16 inches; reddish brown (2.5YR 4/4) sandy clay, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; neutral; abrupt smooth boundary.

B22t—16 to 25 inches; finely mottled dark red (2.5YR 3/6) and red (2.5YR 4/6) sandy clay, dry and moist; moderate fine subangular blocky structure; very hard, very firm; few fine roots; about 15 percent, by volume, rounded and angular chert pebbles; slightly acid; clear smooth boundary.

B23t—25 to 40 inches; finely mottled dark red (2.5YR 3/6) and red (2.5YR 4/6) sandy clay, dry and moist; moderate fine subangular blocky structure; very hard, very firm; 5 to 10 percent chert pebbles 0.5 inch to 2 inches across; slightly acid; abrupt smooth boundary.

C—40 to 60 inches; light reddish brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) moist; interbedded with weakly cemented limestone.

The solum is 35 to 45 inches thick. Reaction ranges from slightly acid to mildly alkaline.

The A horizon is reddish brown or brown.

The B horizon is reddish brown, brown, red, dark red, or dark brown. It is sandy clay or clay.

## Purves series

The Purves series consists of shallow, well drained, gently sloping clayey soils on uplands. The soils formed in residual material that weathered from indurated limestone. Slopes range from 1 to 5 percent.

Typical pedon of Purves clay, 1 to 5 percent slopes; from the intersection of Farm Road 150 and Farm Road 3237 about 8 miles northwest of Kyle, 0.4 mile north on Farm Road 150 and 120 feet west of road, in rangeland:

A11—0 to 10 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; few concretions of calcium carbonate; few limestone pebbles less than 0.1 inch across; calcareous; moderately alkaline; clear smooth boundary.

A12ca—10 to 16 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium and fine subangular blocky structure; very hard, very firm; few fine roots; few concretions of calcium carbonate; few limestone pebbles 0.1 to 0.2 inch across; calcareous; moderately alkaline; clear smooth boundary.

A13ca—16 to 19 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common concretions of calcium carbonate; about 10 percent, by volume, strongly cemented limestone fragments 3 to 6 inches across; calcareous; moderately alkaline; abrupt smooth boundary.

R—19 to 22 inches; indurated fractured limestone.

The thickness of the solum and the depth to indurated limestone range from 8 to 20 inches. The soil is very dark gray, dark gray, very dark grayish brown, dark brown, dark grayish brown, and brown. Coarse fragments make up 0 to 35 percent of the volume. Concretions and coatings and pendants on fragments are secondary carbonates.

## Real series

The Real series consists of shallow, well drained, undulating to steep loamy soils on uplands. These soils formed over interbedded marl and limestone. Slopes range from 1 to 30 percent.

Typical pedon of Real gravelly loam, 1 to 8 percent slopes; from the intersection of U.S. Interstate 35 and Farm Road 150 in Kyle, 2.3 miles northwest on Farm Road 150, 0.4 mile southwest on county road, 0.5 mile west on private road, and 66 feet south of road, in rangeland:

A11—0 to 4 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable; many fine roots; few snail shell fragments; few angular pebbles of soft limestone; calcareous; moderately alkaline; clear wavy boundary.

A12ca—4 to 9 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; common fine roots; few snail shell fragments; about 40 percent, by volume, chalk fragments 1 to 10 inches across; calcareous; moderately alkaline; clear smooth boundary.

A13ca—9 to 14 inches; dark grayish brown (10YR 4/2) extremely stony loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; hard, friable; few fine roots; about 80 percent, by volume, chalk fragments 3 to 12 inches across with soil in spaces between fragments; coatings and pendants of secondary calcium carbonate on fragments; calcareous; moderately alkaline; abrupt wavy boundary.

Crca—14 to 17 inches; strongly cemented platy chalk.

The solum is 8 to 16 inches thick. Coarse fragments of chalk make up 35 to 60 percent of the solum. The fragments are mostly 0.2 inch to 3 inches in diameter in the upper part and 3 to 12 inches in the lower part. The calcium carbonate equivalent ranges from 40 to 70 percent.

The A horizon is dark grayish brown or very dark grayish brown.

The Crca horizon is weakly cemented to strongly cemented chalk.

## Rumple series

The Rumple series consists of moderately deep, well drained, undulating clayey and cherty soils on uplands. The soils formed over indurated fractured limestone. Slopes are 1 to 8 percent.

Typical pedon of Rumple very cherty clay loam, in an area of Rumple-Comfort association, undulating; from the intersection of U.S. Interstate 35 and Farm Road 306 near New Braunfels, 5.5 miles northwest on Farm Road 306 and 50 feet east of road, in rangeland:

A1—0 to 10 inches; dark reddish brown (5YR 3/3) very cherty clay loam, dark reddish brown (5YR 3/2) moist; moderate fine subangular blocky structure; hard, friable; common fine roots; about 35 percent, by volume, angular chert fragments mostly 0.5 to 1 inch across; noncalcareous; mildly alkaline; clear smooth boundary.

B21t—10 to 14 inches; dark reddish brown (2.5YR 3/4) very cherty clay, dark reddish brown (2.5YR 2/4) moist; moderate very fine subangular blocky structure; hard, friable; common fine roots; patchy clay films on peds; about 35 percent, by volume, angular chert fragments mostly 0.5 inch to 2 inches across; noncalcareous; mildly alkaline; abrupt irregular boundary.

B22t—14 to 28 inches; dark reddish brown (2.5YR 3/4) extremely stony clay, dark reddish brown (2.5YR 2/4) moist; few fine roots; about 25 percent, by volume, clayey soil material in vertical and horizontal fractures and solution cavities; 75 percent limestone cobbles and stones and chert pebbles and cobbles; noncalcareous; mildly alkaline; abrupt wavy boundary.

R—28 to 36 inches; coarsely fractured indurated limestone with dark reddish brown clay in crevices.

The thickness of the solum and the depth to indurated limestone range from 20 to 40 inches. Coarse fragments

cover 10 to 25 percent of the surface and are mostly chert, although some are limestone.

The A horizon is dark brown, dark reddish gray, or dark reddish brown. It is cherty clay loam, very cherty clay loam, or cherty clay. Coarse fragments make up 15 to 60 percent of the volume. This horizon is slightly acid or neutral.

The B2t horizon is dark reddish brown, reddish brown, or red. The clay content of the fine-earth fraction ranges from 60 to 75 percent. Coarse fragments make up 35 to 85 percent of the volume. This horizon is slightly acid to mildly alkaline.

## Seawillow series

The Seawillow series consists of deep, well drained, gently sloping to sloping loamy soils on stream terraces. The soils formed in calcareous, loamy alluvial sediment. Slopes range from 1 to 8 percent.

Typical pedon of Seawillow clay loam, 1 to 3 percent slopes; from the intersection of U.S. Interstate 35 and Farm Road 150 in Kyle, 0.6 mile west on Farm Road 150, 0.5 mile west on county road, 2.1 miles south on county road, and 0.5 mile west, in a pasture:

Ap—0 to 4 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; common earthworm casts; common snail shell fragments; calcareous; moderately alkaline; clear smooth boundary.

A1—4 to 11 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable; common fine roots; common earthworm casts; common snail shell fragments; calcareous; moderately alkaline; gradual smooth boundary.

B2ca—11 to 26 inches; very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable; few fine roots; common earthworm casts; common snail shell fragments; common films and threads of calcium carbonate; few rounded limestone pebbles in lower part; calcareous; moderately alkaline; gradual smooth boundary.

Cca—26 to 60 inches; very pale brown (10YR 7/4) clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; common snail shell fragments; common films and threads of calcium carbonate; common rounded limestone pebbles becoming more common with depth; calcareous; moderately alkaline.

The solum is 18 to 40 inches thick. The calcium carbonate equivalent ranges from 40 to 70 percent. Coarse fragments of rounded limestone make up 0 to 15 percent of the volume.

The A horizon is brown or grayish brown.

The B and C horizons are light yellowish brown, brownish yellow, or very pale brown. They are clay loam, silty clay loam, or loam.

## Sunev series

The Sunev series consists of deep, well drained, gently sloping loamy soils on uplands. The soils formed in loamy and clayey material that weathered from limestone. Slopes range from 1 to 5 percent.

Typical pedon of Sunev clay loam, 1 to 3 percent slopes; from the intersection of Ranch Road 32 and Ranch Road 12, about 9 miles west of San Marcos, 7.4 miles west on Ranch Road 32, 1.1 miles north on county road, 1 mile east on private road, 0.1 mile south on private road, and 300 feet east, in cropland:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, firm; common fine roots; common fragments of limestone and snail shells less than 0.1 inch across; calcareous; moderately alkaline; clear smooth boundary.

A11—6 to 11 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and subangular blocky structure; hard, firm; few fine roots; common fragments of limestone and snail shell fragments less than 0.1 inch across; calcareous; moderately alkaline; clear smooth boundary.

B21—11 to 17 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate fine granular and subangular blocky structure; hard, firm; few fine roots; few concretions of calcium carbonate; common fragments of limestone and snail shells less than 0.1 inch across; calcareous; moderately alkaline; clear smooth boundary.

B22ca—17 to 35 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak fine and medium subangular blocky structure; very hard, very firm; few fine roots; common concretions of calcium carbonate; few threads and weakly cemented masses of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B23ca—35 to 45 inches; reddish yellow (7.5YR 6/6) clay loam, strong brown (7.5YR 5/6) moist; weak fine subangular blocky structure; very hard, very firm; few fine roots; about 15 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

Cca—45 to 60 inches; yellow (10YR 7/6) gravelly clay loam, brownish yellow (10YR 6/6) moist; structureless; hard, firm; about 20 percent, by volume, soft masses and concretions of calcium

carbonate; about 5 percent, by volume, limestone gravel; calcareous; moderately alkaline.

The solum is 40 to 70 inches thick. Calcium carbonate makes up 40 to 60 percent of the 10- to 40-inch control section.

The A horizon is dark grayish brown, dark brown, or brown.

The B horizon is light brown, brown, dark yellowish brown, reddish yellow, or strong brown. It is clay or clay loam. Segregated carbonates make up an estimated 5 to 50 percent of the volume. Gravel content ranges from 5 to 35 percent below a depth of 30 inches.

Map unit SuA is more silty than is typical for the Sunev series and is considered a taxadjunct to the series. The difference, however, does not affect the use and management of the soil.

## Tarpley series

The Tarpley series consists of shallow, well drained, gently sloping clayey soils on uplands. The soils formed in material that weathered from indurated limestone. Slopes range from 1 to 3 percent.

Typical pedon of Tarpley clay, 1 to 3 percent slopes; from the intersection of Ranch Road 150 and Ranch Road 1826 about 14 miles northwest of Kyle near Driftwood, 0.8 mile south on Ranch Road 150 and 600 feet east of road, in pasture:

A1—0 to 6 inches; dark brown (7.5YR 3/2) clay, dark brown (7.5YR 3/2) moist; moderate medium and fine blocky structure; very hard, very firm; many fine roots; noncalcareous; neutral; clear smooth boundary.

B2t—6 to 17 inches; dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/2) moist; strong fine blocky structure; very firm, very hard; common fine roots; thin clay films on ped faces; few pressure faces; few filled cracks of dark brown clay; noncalcareous; neutral; abrupt smooth boundary.

R—17 to 21 inches; indurated fractured limestone.

The thickness of the solum and the depth to indurated limestone range from 13 to 20 inches. The soil is slightly acid to mildly alkaline. Limestone and chert fragments cover 0 to 30 percent of the surface and make up 0 to 30 percent of the volume. Cracks more than 1 cm wide extend to a depth of more than 20 inches when the soil is dry. COLE is 0.09 to 0.20.

The A horizon is dark brown, dark reddish brown, or dark reddish gray.

The B horizon is reddish brown and dark reddish brown. The clay content of the fine-earth fraction ranges from 60 to 80 percent.

## Tinn series

The Tinn series consists of deep, somewhat poorly drained, nearly level clayey soils on flood plains. The soils formed in calcareous clayey alluvium. Slopes range from 0 to 1 percent.

Typical pedon of Tinn clay, frequently flooded; from the intersection of Texas 21 and Texas 80 in San Marcos, 8.7 miles north on Texas 21, 3.2 miles northwest on paved county road, and 0.4 mile south of road, in pasture:

A11—0 to 19 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium blocky and subangular blocky structure; very hard, very firm; common fine roots; common fine snail shell fragments; calcareous; moderately alkaline; gradual smooth boundary.

A12—19 to 25 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak medium blocky structure; extremely hard, extremely firm; few fine grass roots; few fine snail shell fragments; calcareous; moderately alkaline; gradual smooth boundary.

A13—25 to 32 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; extremely hard, extremely firm; few faint brown mottles; few pressure faces; few fine snail shell fragments; calcareous; moderately alkaline; clear smooth boundary.

B2—32 to 53 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; extremely hard, extremely firm; few faint brownish and olive mottles; few fine roots; common siliceous pebbles; few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C—53 to 80 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; structureless; extremely hard, extremely firm; common siliceous pebbles; few soft masses of calcium carbonate; calcareous; moderately alkaline.

The A horizon is very dark gray or dark gray in the upper part and dark grayish brown and grayish brown in the lower part. There are brown mottles in the lower part. Some pedons have bedding planes. When the soil is dry, cracks 0.5 inch to 2 inches in width extend to a depth of 30 inches or more.

The B horizon has value about 1 unit higher than that of the A horizon. Most pedons have brownish, yellowish, and olive mottles. Some pedons do not have a B horizon.

The C horizon has mottles of gray, brown, and olive. In some pedons gravel makes up 15 to 50 percent of the volume below a depth of 40 inches.

# formation of the soils

In this section, the factors of soil formation are described and related to the soils in the survey area. The development of soil horizons is discussed, and the geology of the area is described.

## factors of soil formation

Soil is the product of the interaction of five major soil-forming factors. These factors are climate, living organisms, parent material, relief, and time. Climate and living organisms are the active forces of soil formation. They act on the parent material over a period of time. The effects of climate and organisms are modified by relief, or lay of the land.

The interrelationship among these factors is complex. The influence of each factor on soil formation varies from one place to another, and the effect of any one factor is difficult to isolate.

### climate

The climate in Comal and Hays Counties is humid subtropical and is characterized by hot summers and relatively mild winters. Temperature and rainfall are the climatic factors that have the greatest influence on soil formation. In general, the higher the temperature and the amount of rainfall, the more active the physical and chemical processes that promote weathering of parent rock and development of the soil profile.

Rainfall has influenced soil development through the downward movement of carbonates and clay within the soil. The leaching of carbonates has occurred in all soils in varying degrees. The amount of carbonates presently in a soil depends on the amount in the parent material and the amount of water that has moved through the soil. In some of the soils, for example, Bolar, Denton, Doss, Lewisville, and Sunev soils, carbonates have accumulated in the subsoil. In other soils, for example, Anhalt, Comfort, Rumple, and Tarpley soils, carbonates have been completely leached, and the soil is noncalcareous throughout.

The movement of clay particles in soils is much slower than the movement of carbonates. However, Comfort, Rumple, and Tarpley soils have had significant amounts of clay translocated from the surface horizon to the subsoil.

The pattern of rainfall consists of interspersed wet and dry periods, causing certain clays to undergo a continuous shrink-swell cycle. Cracking of these clays during dry periods allows surface soil to fall or wash into the cracks. This continual mixing of surface soil and subsoil prevents the formation of distinct horizons. Anhalt, Houston Black, Branyon, and Heiden soils undergo this shrink-swell cycle.

### parent material

Parent material is the unconsolidated or consolidated mass in which a soil forms. It determines the dominant chemical and mineralogical composition of the soil and influences the rate of soil development. Unconsolidated, or soft, materials weather faster; thus soils form more rapidly in unconsolidated materials than in consolidated, or hard, materials. In Comal and Hays Counties, the parent material of the soils on uplands ranges from strongly indurated limestone to marl, chalk, and shale. On stream terraces, the parent material is unconsolidated, calcareous, alluvial sediment consisting of clay, silt, and gravel. On flood plains, the parent material is unconsolidated, calcareous, recent alluvium consisting of sand, silt, and clay. More detailed information on the different parent materials in the survey area is given in the "Geology" section.

### living organisms

Vegetation, micro-organisms, insects, earthworms, fungi, and all forms of life on and in the soil contribute to soil formation. Organic matter accumulation, gains and losses of plant nutrients, soil mixing, structural stability, and porosity are affected by organisms. Decaying plant roots as well as burrowing animals and insects leave a network of channels and pores that increase the passage of air and water. Trees remove soil minerals from deep in the soil and return them to the soil surface through decaying leaves. Grasses, because of their fibrous root systems, add more organic matter to the soil, especially the subsoil, than do trees. Soils that formed under grasses are generally darker in color than soils that developed under forest vegetation. Soils that formed under coniferous trees tend to be more acid than those that formed under deciduous trees, because conifers are lower in base elements, including calcium, magnesium, and potassium.

The soils in the survey area developed mainly under grassland vegetation. Generally the surface layer is dark

and has the good structure that is associated with soils that formed under grassland vegetation.

### relief

Relief influences the formation of soils in Comal and Hays Counties by its effect on runoff, erosion, and drainage. More water enters soils that are nearly level or gently sloping because runoff is slower. Consequently, leaching and profile development are increased. Runoff is more rapid on soils that are strongly sloping or steep. Steeper soils are more likely to erode and thus are less likely to be deep. Generally, the profile is less well developed. Steeper soils tend to be more droughty because less water enters the soil. Droughtiness affects vegetation and crops.

### time

The length of time in which climate, living organisms, and topography have acted on parent material affects soil characteristics. Soils that have been weathered for a short period resemble the parent material more than those weathered for a longer period. Soils that formed in recent alluvium on bottom lands and stream terraces are younger than soils that formed on uplands. Boerne soils, for example, formed in loamy alluvium and are young, sandy loam soils, whereas Comfort soils formed in limestone residuum on uplands and are older, clayey soils.

## soil horizon development

The soil profile records the activities of the soil-forming factors. A succession of layers, or horizons, is formed, extending from the surface down to the parent material. The horizons differ in one or more properties, for example, thickness, color, texture, structure, consistence, porosity, and reaction.

Most profiles consist of three major horizons, designated the A, B, and C horizons. In some young soils, a B horizon has not developed. In other soils, a Ccam horizon, which is an indurated calcium carbonate horizon, is present. Several processes are involved in the formation of horizons. In Comal and Hays Counties, the main processes are accumulation of organic matter, leaching and accumulation of calcium carbonate and bases, and formation and translocation of silicate clay minerals. In most soils, several processes have been active.

The A horizon is the surface layer. It is either a horizon of maximum accumulation of organic matter, called the A1 horizon, or a horizon of maximum leaching of materials, called the A2 horizon. None of the soils in the survey area has an A2 horizon, mainly because rainfall is not sufficient for maximum leaching. If a soil is plowed, the upper part of the A horizon is disturbed. This disturbed layer is called the Ap horizon.

The B horizon lies directly below the A horizon. It is the horizon of maximum accumulation of dissolved or suspended materials, for example, iron or clay, or it is an altered horizon whose structure is distinct from that of the A horizon but shows little evidence of clay translocation or accumulation. A B horizon that has a significant amount of clay accumulation is called a Bt horizon. A Bt horizon generally is firmer than the horizons directly above and below and generally has blocky structure. The Pedernales soil has a distinct Bt horizon. Rumple and Tarpley soils have a Bt horizon that is not distinct because of the high content of clay. A subsurface layer that has distinct structure but little evidence of clay accumulation is called a B horizon, without the "t." Austin, Bolar, and Lewisville soils have a B horizon.

The C horizon is relatively unchanged by the soil-forming processes; however, it has been somewhat modified by weathering. Lewisville, Krum, and Seawillow soils have a C horizon. If the C horizon is weathered bedrock, for example, partly consolidated soft limestone, caliche, chalk, or shale, it is called a Cr horizon.

The Ccam horizon is an underlying indurated layer of cemented caliche that has imbedded gravel. Gruene soils have a Ccam horizon.

A soil horizon that has a significant accumulation of calcium carbonate is designated by the addition of "ca." Generally this designation is applied to a B horizon, although it can be an A or a C horizon. Real soils have an A1ca horizon, and Sunev soils have a Bca horizon and a Cca horizon.

The soils in the survey area that have a high shrink-swell potential have an AC horizon. These soils are clayey and have a large amount of montmorillonite. When these soils dry, they shrink, and cracks form. The cracks extend into the C horizon. Soil material from the A horizon falls into the cracks or is washed into the cracks by rain. As the soil soaks up the water, it swells. Because of the small space for expansion, the soil material is pushed up forming a gilgai microrelief of low knolls and depressions. In this manner, the A and C horizons are continually mixed, and a B horizon does not form. Branyon, Heiden, and Houston Black soils have an AC horizon.

An R layer underlies many of the soils in the survey area and is generally indurated limestone bedrock. In some places, it is dolomitic limestone. Chert nodules imbedded in the limestone bedrock are the source of the chert gravel and cobbles in Rumple soils. The chert remained in the soil after the more soluble limestone dissolved. Other soils that have an underlying R layer are Denton, Eckrant, and Comfort soils.

## geology

Max D. Bircket, geologist, Soil Conservation Service, prepared this section.

Comal and Hays Counties lie within two physiographic areas, the Edwards Plateau and the Black Prairie. These physiographic areas are essentially equivalent to the similarly named Edwards Plateau and Texas Blackland Prairie major land resource areas. Approximately four-fifths of the survey area is in the Edwards Plateau. The topography is undulating to hilly. The underlying material is erosion-resistant limestone and limestone interbedded with clay and marl. Drainage is generally immature, particularly where stream courses traverse massive crystalline limestone. The southeastern one-fifth of Comal and Hays Counties is in the Black Prairie. The topography is gently undulating to gently rolling, and relief is low. The underlying material is relatively erodible chalk and clay-shale. Drainage is well developed.

The Balcones fault zone is the dominant geological structure in the survey area. It extends through Comal and Hays Counties in a northeast-southwest direction. Its principal topographic expression, the Balcones Escarpment, forms an abrupt boundary between the Edwards Plateau and the Black Prairie. All displacement is the result of gravity or normal faulting with the footwall generally being upthrown to the northwest. In a few areas, however, the footwall is upthrown to the southeast. This faulting, which has exposed clay-shale beds between hard, erosion-resistant limestone, has had a significant impact on the soils and their location. Faulting has to some extent controlled or strongly influenced stream courses and patterns.

The parent material of the soils in Comal and Hays Counties derived from sedimentary deposits and rocks of Recent, Pleistocene, and Cretaceous age. Cretaceous rocks are the oldest and range from the relatively insignificant Sycamore Sand and Hensell Sand to the dominant interbedded limestone-marl, limestone, chalk, and chalk-marl of the Glen Rose, Edwards Limestone, Austin Chalk, and Pecan Gap Chalk Formations, respectively. Pleistocene deposits are mostly fluviatile terraces of clay, silt, sand, and gravel. Recent deposits are clay, silt, sand, gravel, and cobbles derived from older Pleistocene and Cretaceous strata and are in the flood-prone areas.

The oldest rocks cropping out in Comal and Hays Counties are in the Travis Peak Formation. The Sycamore Sand, Cow Creek Limestone, and Hensell Sand members of this formation are at the surface in the northernmost part of Hays County near the Pedernales River. The Cow Creek Limestone and Hensell Sand crop out in northwestern Comal County, west of Canyon Lake and in the valley and periphery of the Guadalupe River and Rebecca Creek. The Travis Peak Formation is relatively insignificant as a source of parent material because the area of outcrop is very small.

The Glen Rose Formation overlies the Travis Peak Formation. It crops out mainly in the northwestern half of the survey area and is the dominant geological unit in surface area. The Glen Rose Formation consists of interbedded limestone and marl or clay. Because the limestone is much more resistant to erosion than the marl and clay, the topography consists of hill slopes having a benched appearance. Brackett, Comfort, Bolar, and associated soils developed over the Glen Rose Formation.

In ascending order, the Walnut Formation, the Comanche Peak Limestone, and the Edwards Limestone overlie the Glen Rose Formation. These formations crop out southeast of the Glen Rose Formation within a northeast-southwest trending band averaging about 7 miles in width. Comfort, Rumple, Eckrant, and associated soils developed over the Walnut Formation, the Comanche Peak Limestone, and the Edwards Limestone.

The Walnut Formation crops out in the central part of the survey area near the Comal-Hays county line. It ranges in thickness from a few inches to about 5 feet in Comal County and from 5 to 15 feet in Hays County (*2, 3*). It is relatively insignificant as a source of parent material because the area of outcrop is small. The Comanche Peak Limestone is mostly hard, massive, and in some locations, dolomitic limestone that resembles the overlying Edwards Limestone. In some areas, the lower part of the formation is marl and clay somewhat similar to the underlying Walnut Formation. The Edwards Limestone has the second most extensive outcrop in the survey area. It is mostly hard, massive, crystalline, and, in some areas, dolomitic limestone. A distinguishing lithologic characteristic of this formation is the presence of chert nodules, many of which have weathered out and are now part of the solum. The Edwards Limestone has been subjected to considerable solution, as indicated by scattered sinks on the surface and a generally honeycombed appearance.

Because of its fractured, vuggy, and cavernous character, the Edwards Limestone is an extremely important ground-water recharge area and aquifer. It furnishes large quantities of water of high quality for industrial, municipal, recreational, and domestic uses. It is imperative that prudent judgment be used in managing this important resource. The nature of the soils in the area is a principal factor in determining land use and management and the resulting effects on the aquifer.

The Edwards Limestone is overlain, in ascending order, by the Georgetown Formation, Del Rio Clay (Grayson Marl), and Buda Limestone. Outcrops of these formations occur where crustal movement has been intense in the fault zone. In the survey area, the Georgetown Formation ranges from a few feet to 32 feet in thickness, the Del Rio Clay is about 44 feet thick, and the Buda Limestone is about 30 to 60 feet thick. Although the thickness of these formations is relatively

limited, their lithology, stratigraphy, and geologic structure have controlled or substantially influenced location, extent, and type of soil. Krum, Medlin, Eckrant, and associated soils developed over these formations. The Buda Limestone generally occurs as a resistant cap on small hills and narrow ridges where shallow Eckrant soils have formed. In many areas, faulting has tilted and exposed the Del Rio Clay on hill slopes where the deep Medlin soils have formed. Erosion of these slopes has caused deposition of clay material on foot slopes where Drum soils have developed.

The Eagle Ford Group overlies the Buda Limestone and crops out in Comal and Hays Counties in the Balcones fault zone. It consists of calcareous shale and sandy limestone strata about 30 feet thick and is located generally on top of hills and ridges. The Eagle Ford is not considered to be a significant source of soil parent material in the survey area because it crops out in only a few small areas.

Austin Chalk overlies the Eagle Ford Group. This formation has been significant in the development of the soils on the southeastern part of the Balcones Escarpment. In most places, it is in fault contact at the surface with the overlying Pecan Gap Chalk or with the Ozan Formation, which consists of clay and marl strata. The Marlbrook Marl, youngest of the Cretaceous strata that crop out in the survey area, is exposed at the surface in eastern Hays County. Stephen, Austin, Houston Black, and associated soils developed over the Austin Chalk and the Pecan Gap Chalk. Heiden, Houston Black, and associated soils developed over the clay and marl of the Ozan Formation, the Pecan Gap Chalk, and the Marlbrook Marl.

Pleistocene fluviatile terrace deposits are located in both counties southeast of the Balcones Escarpment. The oldest deposits are in topographically high areas that have a northwest-southeast trend roughly parallel to the regional drainage. The Leona Formation extends from southwest of Kyle into Caldwell County and is an example of a topographically high, nearly level to sloping stream terrace. Branyon, Krum, and associated soils developed on these high terraces. The somewhat younger, gravelly to clayey, fluviatile terrace deposits are along major streams in the Edwards Plateau and Blackland Prairie. They are at a lower elevation than the adjacent Pleistocene deposits. Lewisville, Gruene, Krum, and associated soils developed on these low terraces. Recent deposits of gravel, sand, silt, and clay are on modern flood plains. Boerne, Oakalla, Orif, and Tinn soils developed on these flood plains.

# references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) DeCook, H. J. 1960. Geology and ground-water resources of Hays County, Texas. Texas Board of Water Engineers Bull. 6004, 170 pp.

(4) George, W. C. 1952. Geology and ground-water resources of Comal County, Texas. U.S. Geol. Surv. Water Supply Paper 1138, 126 pp.

(5) United States Department of Agriculture. 1906. Soil survey of the San Marcos Area, Texas. 37 pp.

(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(7) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 764 pp., illus.

# glossary

**ABC soil.** A soil having an A, a B, and a C horizon.

**AC soil.** A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

**Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.

**Area reclaim** (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

**Association, soil.** A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

**Available water capacity (available moisture capacity).** The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

| | *Inches* |
|---|---|
| Very low | 0 to 3 |
| Low | 3 to 6 |
| Moderate | 6 to 9 |
| High | 9 to 12 |
| Very high | More than 12 |

**Base saturation.** The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

**Bedding planes.** Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Bench terrace.** A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

**Bottom land.** The normal flood plain of a stream, subject to flooding.

**Boulders.** Rock fragments larger than 2 feet (60 centimeters) in diameter.

**Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

**Caliche.** A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

**Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

**Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

**Cemented pan.** A strongly cemented or indurated layer of caliche.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

**Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

**Claypan.** A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

**Climax vegetation.** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

**Coarse fragments.** If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

**Cobblestone (or cobble).** A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

**Colluvium.** Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

**Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

**Complex, soil.** A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

*Cemented.*—Hard; little affected by moistening.

**Control section.** The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

**Corrosive.** High risk of corrosion to uncoated steel or deterioration of concrete.

**Cover crop.** A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

**Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.

**Decreasers.** The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

**Deferred grazing.** Postponing grazing or arresting grazing for a prescribed period.

**Depth to rock** (in tables). Bedrock is too near the surface for the specified use.

**Diversion (or diversion terrace).** A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

**Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

*Excessively drained.*—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

*Somewhat excessively drained.*—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.*—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

*Moderately well drained.*—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

*Somewhat poorly drained.*—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from

seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.*—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained.*—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Droughty.** The soil holds little water, or rainfall is so low that nonirrigated farming is not feasible.

**Dusty.** Soil particles easily detached, forming dust.

**Electrical conductivity (EC).** The reciprocal of the electrical resistivity. The resistivity is the resistance, in ohms, of a conductor which is 1 cm long and has a cross sectional area of 1 $cm^2$. Hence, electrical conductivity is expressed in reciprocal ohms per centimeter, or mhos per centimeter. It is a measure of the soluble salts in soil or water.

**Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

*Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

*Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

**Escarpment.** A steep slope or cliff separating two comparatively level or more gently sloping surfaces.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

**Fast intake** (in tables). The rapid movement of water into the soil.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

**Flagstone.** A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Foot slope.** The inclined surface at the base of a hill.

**Forb.** Any herbaceous plant not a grass or a sedge.

**Fragipan.** A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

**Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

**Gilgai.** Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

**Grassed waterway.** A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

**Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

**Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table.

**Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

**Hardpan.** A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is

cemented by iron oxide, silica, calcium carbonate, or other substance.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

*O horizon.*—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

*A horizon.*—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

*C horizon.*—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

*R layer.*—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

**Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.

**Hydrologic soil groups.** Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

**Increasers.** Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**Intake rate.** The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

| | |
|---|---|
| Less than 0.2 | very low |
| 0.2 to 0.4 | low |
| 0.4 to 0.75 | moderately low |
| 0.75 to 1.25 | moderate |
| 1.25 to 1.75 | moderately high |
| 1.75 to 2.5 | high |
| More than 2.5 | very high |

**Invaders.** On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are—

*Border.*—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

*Basin.*—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

*Controlled flooding.*—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

*Corrugation.*—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

*Drip (or trickle).*—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

*Furrow.*—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

*Sprinkler.*—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

*Subirrigation.*—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

*Wild flooding.*—Water, released at high points, is allowed to flow onto an area without controlled distribution.

**Large stones** (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Low strength.** The soil is not strong enough to support loads.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

**Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.

**Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

**Munsell notation.** A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

**Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

**Organic matter.** Plant and animal residue in the soil in various stages of decomposition.

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

**Pedon.** The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

**Percolation.** The downward movement of water through the soil.

**Percs slowly** (in tables). The slow movement of water through the soil adversely affecting the specified use.

**Permeability.** The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

| | |
|---|---|
| Very slow | less than 0.06 inch |
| Slow | 0.06 to 0.20 inch |
| Moderately slow | 0.2 to 0.6 inch |
| Moderate | 0.6 inch to 2.0 inches |
| Moderately rapid | 2.0 to 6.0 inches |
| Rapid | 6.0 to 20 inches |
| Very rapid | more than 20 inches |

**Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

**pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

**Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

**Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

**Plastic limit.** The moisture content at which a soil changes from semisolid to plastic.

**Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Rangeland.** Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

**Range condition.** The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

**Range site.** An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the

product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

**Reaction, soil.** A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

| | *pH* |
|---|---|
| Extremely acid | Below 4.5 |
| Very strongly acid | 4.5 to 5.0 |
| Strongly acid | 5.1 to 5.5 |
| Medium acid | 5.6 to 6.0 |
| Slightly acid | 6.1 to 6.5 |
| Neutral | 6.6 to 7.3 |
| Mildly alkaline | 7.4 to 7.8 |
| Moderately alkaline | 7.9 to 8.4 |
| Strongly alkaline | 8.5 to 9.0 |
| Very strongly alkaline | 9.1 and higher |

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Rill.** A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

**Rippable.** Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

**Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

**Sandstone.** Sedimentary rock containing dominantly sand-size particles.

**Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

**Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

**Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Sheet erosion.** The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

**Shrink-swell.** The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Sinkhole.** A depression in the landscape where limestone has been dissolved.

**Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

**Slope.** The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

**Slope** (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

**Slow intake** (in tables). The slow movement of water into the soil.

**Small stones** (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

**Soil.** A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Soil separates.** Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

| | *Millimeters* |
|---|---|
| Very coarse sand | 2.0 to 1.0 |
| Coarse sand | 1.0 to 0.5 |
| Medium sand | 0.5 to 0.25 |
| Fine sand | 0.25 to 0.10 |
| Very fine sand | 0.10 to 0.05 |

| | |
|---|---|
| Silt | 0.05 to 0.002 |
| Clay | less than 0.002 |

**Solum.** The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

**Stones.** Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

**Stony.** Refers to a soil containing stones in numbers that interfere with or prevent tillage.

**Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**Stubble mulch.** Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Subsoiling.** Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

**Substratum.** The part of the soil below the solum.

**Subsurface layer.** Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

**Summer fallow.** The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

**Surface layer.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

**Taxadjuncts.** Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

**Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Too clayey.** Soil that is slippery and sticky when wet and dries slowly.

# tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-78 at New Braunfels, Texas]

| Month | Temperature | | | | | | Precipitation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average daily maximum | Average daily minimum | Average | 2 years in 10 will have-- Maximum temperature higher than-- | 2 years in 10 will have-- Minimum temperature lower than-- | Average number of growing degree days[1] | Average | 2 years in 10 will have-- Less than-- | 2 years in 10 will have-- More than-- | Average number of days with 0.10 inch or more | Average snowfall |
| | °F | °F | °F | °F | °F | Units | In | In | In | | In |
| January---- | 61.9 | 37.8 | 49.9 | 85 | 17 | 152 | 1.77 | .49 | 2.80 | 4 | .1 |
| February--- | 66.9 | 41.7 | 54.3 | 88 | 22 | 204 | 2.36 | .78 | 3.65 | 5 | .3 |
| March------ | 74.8 | 48.3 | 61.6 | 93 | 28 | 377 | 1.56 | .52 | 2.41 | 4 | .0 |
| April------ | 81.4 | 57.6 | 69.5 | 95 | 37 | 585 | 3.17 | 1.15 | 4.85 | 5 | .0 |
| May-------- | 86.7 | 64.2 | 75.5 | 98 | 46 | 791 | 4.59 | 1.48 | 7.12 | 5 | .0 |
| June------- | 93.3 | 70.8 | 82.0 | 101 | 59 | 960 | 3.07 | 1.08 | 4.75 | 4 | .0 |
| July------- | 96.6 | 72.8 | 84.7 | 105 | 66 | 1,076 | 1.44 | .25 | 2.35 | 3 | .0 |
| August----- | 96.7 | 72.2 | 84.5 | 104 | 63 | 1,070 | 2.85 | .56 | 4.61 | 4 | .0 |
| September-- | 90.8 | 68.1 | 79.4 | 102 | 52 | 882 | 4.22 | 1.32 | 6.58 | 5 | .0 |
| October---- | 82.5 | 57.7 | 70.2 | 95 | 40 | 626 | 3.64 | .95 | 5.79 | 5 | .0 |
| November--- | 71.8 | 47.3 | 59.6 | 87 | 27 | 302 | 2.81 | .77 | 4.46 | 4 | .0 |
| December--- | 64.9 | 40.1 | 52.5 | 84 | 22 | 156 | 1.98 | .67 | 3.06 | 4 | .0 |
| Yearly: | | | | | | | | | | | |
| Average-- | 80.7 | 56.6 | 68.6 | --- | --- | --- | --- | --- | --- | --- | --- |
| Extreme-- | --- | --- | --- | 105 | 17 | --- | --- | --- | --- | --- | --- |
| Total---- | --- | --- | --- | --- | --- | 7,181 | 33.46 | 23.98 | 42.37 | 52 | .4 |

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature (50° F) below which growth is minimal for the principal crops in the area.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-78 at New Braunfels, Texas]

| Probability | Temperature | | |
|---|---|---|---|
| | 24° F or lower | 28° F or lower | 32° F or lower |
| Last freezing temperature in spring: | | | |
| 1 year in 10 later than-- | February 18 | March 17 | March 26 |
| 2 years in 10 later than-- | February 9 | March 8 | March 20 |
| 5 years in 10 later than-- | January 24 | February 20 | March 10 |
| First freezing temperature in fall: | | | |
| 1 year in 10 earlier than-- | November 29 | November 18 | November 11 |
| 2 years in 10 earlier than-- | December 11 | November 27 | November 18 |
| 5 years in 10 earlier than-- | January 3 | December 12 | November 30 |

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-78 at New Braunfels, Texas]

| Probability | Length of growing season if daily minimum temperature is-- | | |
|---|---|---|---|
| | Higher than 24° F | Higher than 28° F | Higher than 32° F |
| | Days | Days | Days |
| 9 years in 10 | 301 | 267 | 238 |
| 8 years in 10 | 312 | 277 | 247 |
| 5 years in 10 | 335 | 295 | 264 |
| 2 years in 10 | >365 | 313 | 281 |
| 1 year in 10 | >365 | 322 | 290 |

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

| Map symbol | Soil name | Comal County | Hays County | Total-- Area | Extent |
|---|---|---|---|---|---|
| | | Acres | Acres | Acres | Pct |
| AgC3 | Altoga silty clay, 2 to 5 percent slopes, eroded | 1,280 | 1,610 | 2,890 | 0.4 |
| AgD3 | Altoga silty clay, 5 to 8 percent slopes, eroded | 160 | 1,150 | 1,310 | 0.2 |
| AnA | Anhalt clay, 0 to 1 percent slopes | 740 | 400 | 1,140 | 0.1 |
| AnB | Anhalt clay, 1 to 3 percent slopes | 2,230 | 2,200 | 4,430 | 0.6 |
| AuB | Austin-Castephen complex, 1 to 3 percent slopes | 170 | 2,050 | 2,220 | 0.3 |
| AuC3 | Austin-Castephen complex, 2 to 5 percent slopes, eroded | 210 | 520 | 730 | 0.1 |
| BoB | Boerne fine sandy loam, 1 to 3 percent slopes | 2,150 | 660 | 2,810 | 0.3 |
| BrB | Bolar clay loam, 1 to 3 percent slopes | 7,280 | 9,130 | 16,410 | 2.1 |
| BtD | Brackett-Rock outcrop-Comfort complex, undulating | 43,430 | 67,950 | 111,380 | 14.1 |
| BtG | Brackett-Rock outcrop-Real complex, steep | 54,400 | 49,720 | 104,120 | 13.1 |
| ByA | Branyon clay, 0 to 1 percent slopes | 5,770 | 7,520 | 13,290 | 1.7 |
| ByB | Branyon clay, 1 to 3 percent slopes | 2,400 | 2,490 | 4,890 | 0.6 |
| CaC3 | Castephen clay loam, 3 to 5 percent slopes, eroded | 130 | 690 | 820 | 0.1 |
| CrD | Comfort-Rock outcrop complex, undulating | 84,270 | 64,962 | 149,232 | 18.8 |
| DeB | Denton silty clay, 1 to 3 percent slopes | 4,850 | 3,980 | 8,830 | 1.1 |
| DeC3 | Denton silty clay, 1 to 5 percent slopes, eroded | 570 | 540 | 1,110 | 0.1 |
| DoC | Doss silty clay, 1 to 5 percent slopes | 2,660 | 12,970 | 15,630 | 2.0 |
| ErG | Eckrant-Rock outcrop complex, steep | 23,070 | 8,250 | 31,320 | 4.0 |
| FeF4 | Ferris clay, 5 to 20 percent slopes, severely eroded | 760 | 1,870 | 2,630 | 0.3 |
| GrC | Gruene clay, 1 to 5 percent slopes | 1,490 | 4,610 | 6,100 | 0.8 |
| HeB | Heiden clay, 1 to 3 percent slopes | 3,000 | 4,820 | 7,820 | 1.0 |
| HeC3 | Heiden clay, 3 to 5 percent slopes, eroded | 4,510 | 11,440 | 15,950 | 2.0 |
| HeD3 | Heiden clay, 5 to 8 percent slopes, eroded | 670 | 3,790 | 4,460 | 0.6 |
| HgD | Heiden gravelly clay, 3 to 8 percent slopes | 920 | 1,620 | 2,540 | 0.3 |
| HoB | Houston Black clay, 1 to 3 percent slopes | 4,320 | 15,990 | 20,310 | 2.6 |
| HvB | Houston Black gravelly clay, 1 to 3 percent slopes | 1,520 | 2,450 | 3,970 | 0.5 |
| HvD | Houston Black gravelly clay, 3 to 8 percent slopes | 1,280 | 3,240 | 4,520 | 0.6 |
| KrA | Krum clay, 0 to 1 percent slopes | 2,250 | 2,080 | 4,330 | 0.5 |
| KrB | Krum clay, 1 to 3 percent slopes | 4,410 | 8,160 | 12,570 | 1.6 |
| KrC | Krum clay, 3 to 5 percent slopes | 340 | 630 | 970 | 0.1 |
| LeA | Lewisville silty clay, 0 to 1 percent slopes | 1,700 | 2,440 | 4,140 | 0.5 |
| LeB | Lewisville silty clay, 1 to 3 percent slopes | 4,740 | 4,340 | 9,080 | 1.2 |
| MEC | Medlin-Eckrant association, undulating | 2,780 | 870 | 3,650 | 0.5 |
| MED | Medlin-Eckrant association, hilly | 1,120 | 1,620 | 2,740 | 0.3 |
| Oa | Oakalla silty clay loam, rarely flooded | 650 | 1,230 | 1,880 | 0.2 |
| Ok | Oakalla soils, frequently flooded | 970 | 760 | 1,730 | 0.2 |
| Or | Orif soils, frequently flooded | 1,090 | 2,110 | 3,200 | 0.4 |
| PdB | Pedernales fine sandy loam, 1 to 5 percent slopes | 0 | 280 | 280 | * |
| Pt | Pits | 1,460 | 1,220 | 2,680 | 0.3 |
| PuC | Purves clay, 1 to 5 percent slopes | 4,680 | 3,220 | 7,900 | 1.0 |
| RaD | Real gravelly loam, 1 to 8 percent slopes | 3,710 | 4,880 | 8,590 | 1.1 |
| RcD | Real-Comfort-Doss complex, undulating | 13,390 | 29,550 | 42,940 | 5.5 |
| RUD | Rumple-Comfort association, undulating | 46,500 | 60,810 | 107,310 | 13.5 |
| SeB | Seawillow clay loam, 1 to 3 percent slopes | 880 | 850 | 1,730 | 0.2 |
| SeD | Seawillow clay loam, 3 to 8 percent slopes | 690 | 950 | 1,640 | 0.2 |
| SuA | Sunev silty clay loam, 0 to 1 percent slopes | 1,790 | 810 | 2,600 | 0.3 |
| SuB | Sunev clay loam, 1 to 3 percent slopes | 3,120 | 6,880 | 10,000 | 1.3 |
| TaB | Tarpley clay, 1 to 3 percent slopes | 2,480 | 3,310 | 5,790 | 0.7 |
| Tn | Tinn clay, frequently flooded | 1,650 | 5,020 | 6,670 | 0.9 |
| | Water | 8,240 | 158 | 8,398 | 1.1 |
| | Total | 362,880 | 428,800 | 791,680 | 100.0 |

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

| Map symbol and soil name | Cotton lint | Grain sorghum | Corn | Wheat | Oats | Pasture |
|---|---|---|---|---|---|---|
| | Lb | Bu | Bu | Bu | Bu | AUM* |
| AgC3: Altoga | 225 | 35 | 25 | --- | 35 | 6.0 |
| AgD3: Altoga | --- | --- | --- | --- | --- | 5.0 |
| AnA: Anhalt | --- | 45 | --- | --- | 50 | 8.0 |
| AnB: Anhalt | --- | 45 | --- | --- | 50 | 8.0 |
| AuB: Austin-Castephen | --- | 65 | --- | --- | 62 | 5.0 |
| AuC3: Austin-Castephen | --- | 52 | --- | --- | 42 | 4.5 |
| BoB: Boerne | --- | 35 | --- | 15 | 40 | 4.0 |
| BrB: Bolar | --- | 35 | --- | --- | 35 | 5.0 |
| BtD: Brackett-Rock outcrop-Comfort | --- | --- | --- | --- | --- | --- |
| BtG: Brackett-Rock outcrop-Real | --- | --- | --- | --- | --- | --- |
| ByA: Branyon | 550 | 90 | --- | 35 | --- | 8.0 |
| ByB: Branyon | 550 | 85 | --- | --- | --- | 8.0 |
| CaC3: Castephen | --- | 35 | --- | --- | 35 | 3.0 |
| CrD: Comfort-Rock outcrop | --- | --- | --- | --- | --- | --- |
| DeB: Denton | 350 | 65 | 40 | 35 | 60 | 6.0 |
| DeC3: Denton | 250 | 50 | --- | 25 | 45 | 5.0 |
| DoC: Doss | --- | --- | --- | 20 | 60 | 4.0 |
| ErG: Eckrant-Rock outcrop | --- | --- | --- | --- | --- | --- |
| FeF4: Ferris | --- | --- | --- | --- | --- | 3.5 |
| GrC: Gruene | --- | 30 | --- | 20 | 30 | 2.5 |
| HeB: Heiden | 400 | 80 | 60 | 35 | --- | 8.0 |

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

| Map symbol and soil name | Cotton lint | Grain sorghum | Corn | Wheat | Oats | Pasture |
|---|---|---|---|---|---|---|
| | Lb | Bu | Bu | Bu | Bu | AUM* |
| HeC3----------------------- Heiden | 350 | 45 | 45 | --- | --- | 6.0 |
| HeD3----------------------- Heiden | --- | 30 | --- | --- | --- | 3.5 |
| HgD------------------------ Heiden | 350 | 50 | 40 | --- | --- | 4.5 |
| HoB, HvB------------------- Houston Black | 550 | 85 | 55 | 35 | 90 | 9.5 |
| HvD------------------------ Houston Black | 400 | 80 | 50 | 25 | 65 | 7.5 |
| KrA------------------------ Krum | 450 | 75 | --- | --- | 70 | 8.0 |
| KrB------------------------ Krum | 400 | 70 | --- | --- | 70 | 8.0 |
| KrC------------------------ Krum | 350 | 65 | --- | --- | 50 | 6.0 |
| LeA------------------------ Lewisville | 500 | 85 | --- | --- | 70 | 7.5 |
| LeB------------------------ Lewisville | 500 | 80 | --- | --- | 70 | 7.5 |
| MEC: | | | | | | |
| Medlin------------------- | 250 | 45 | --- | 35 | --- | 5.0 |
| Eckrant------------------ | --- | --- | --- | --- | --- | --- |
| MED: | | | | | | |
| Medlin------------------- | --- | --- | --- | --- | --- | --- |
| Eckrant------------------ | --- | --- | --- | --- | --- | --- |
| Oa------------------------- Oakalla | --- | 65 | --- | 25 | 60 | 6.5 |
| Ok------------------------- Oakalla | --- | --- | --- | --- | --- | 6.5 |
| Or------------------------- Orif | --- | --- | --- | --- | --- | --- |
| PdB------------------------ Pedernales | --- | 35 | --- | 20 | 45 | 4.0 |
| Pt. Pits | | | | | | |
| PuC------------------------ Purves | --- | 25 | --- | 20 | 40 | 3.5 |
| RaD------------------------ Real | --- | --- | --- | --- | --- | --- |
| RcD------------------------ Real-Comfort-Doss | --- | --- | --- | --- | --- | --- |
| RUD: | | | | | | |
| Rumple------------------- | --- | --- | --- | --- | --- | --- |
| Comfort------------------ | --- | --- | --- | --- | --- | --- |

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

| Map symbol and soil name | Cotton lint | Grain sorghum | Corn | Wheat | Oats | Pasture |
|---|---|---|---|---|---|---|
| | Lb | Bu | Bu | Bu | Bu | AUM* |
| SeB------------------------ Seawillow | 250 | 45 | --- | --- | 45 | 5.0 |
| SeD------------------------ Seawillow | --- | 35 | --- | --- | 30 | 4.5 |
| SuA------------------------ Sunev | 300 | 70 | 40 | --- | 60 | 6.5 |
| SuB------------------------ Sunev | 200 | 35 | 30 | --- | 50 | 5.5 |
| TaB------------------------ Tarpley | --- | 25 | --- | --- | 30 | 2.5 |
| Tn------------------------- Tinn | --- | --- | --- | --- | --- | 8.0 |

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--RANGELAND PRODUCTIVITY

[Only the soils that support rangeland vegetation suitable for grazing are listed]

| Map symbol and soil name | Range site | Potential annual production for kind of growing season | | |
|---|---|---|---|---|
| | | Favorable | Average | Unfavorable |
| | | Lb/acre | Lb/acre | Lb/acre |
| AgC3, AgD3 Altoga | Clay Loam | 6,500 | 5,000 | 3,800 |
| AnA, AnB Anhalt | Deep Redland | 6,000 | 5,000 | 3,000 |
| AuB,* AuC3:* | | | | |
| Austin | Clay Loam | 6,500 | 5,000 | 3,000 |
| Castephen | Chalky Ridge | 4,250 | 3,250 | 1,900 |
| BoB Boerne | Loamy Bottomland | 4,500 | 3,700 | 2,000 |
| BrB Bolar | Clay Loam | 6,000 | 5,000 | 3,000 |
| BtD:* | | | | |
| Brackett | Adobe | 4,000 | 3,200 | 1,800 |
| Rock outcrop. | | | | |
| Comfort | Low Stony Hills | 3,000 | 2,500 | 1,500 |
| BtG:* | | | | |
| Brackett | Steep Adobe | 3,000 | 2,200 | 1,500 |
| Rock outcrop. | | | | |
| Real | Steep Adobe | 3,500 | 2,500 | 1,500 |
| ByA, ByB Branyon | Blackland | 7,000 | 5,500 | 3,500 |
| CaC3 Castephen | Chalky Ridge | 4,250 | 3,250 | 1,900 |
| CrD:* | | | | |
| Comfort | Low Stony Hills | 3,000 | 2,500 | 1,500 |
| Rock outcrop. | | | | |
| DeB, DeC3 Denton | Clay Loam | 6,500 | 5,000 | 3,000 |
| DoC Doss | Shallow | 3,000 | 2,500 | 1,800 |
| ErG:* | | | | |
| Eckrant | Steep Rocky | 1,800 | 1,400 | 800 |
| Rock outcrop. | | | | |
| FeF4 Ferris | Eroded Blackland | 7,000 | 5,500 | 4,000 |
| GrC Gruene | Shallow | 4,000 | 2,800 | 1,800 |
| HeB, HeC3, HeD3, HgD Heiden | Blackland | 7,000 | 6,000 | 3,500 |
| HoB, HvB, HvD Houston Black | Blackland | 7,000 | 6,000 | 3,500 |

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

| Map symbol and soil name | Range site | Potential annual production for kind of growing season: Favorable Lb/acre | Average Lb/acre | Unfavorable Lb/acre |
|---|---|---|---|---|
| KrA, KrB, KrC------------ Krum | Clay Loam------------------------------ | 6,500 | 6,000 | 4,000 |
| LeA, LeB----------------- Lewisville | Clay Loam------------------------------ | 6,500 | 5,500 | 3,500 |
| MEC:* | | | | |
| Medlin------------------ | Blackland------------------------------ | 6,000 | 5,000 | 3,000 |
| Eckrant----------------- | Low Stony Hills------------------------ | 3,000 | 2,500 | 1,500 |
| MED:* | | | | |
| Medlin------------------ | Blackland------------------------------ | 6,000 | 5,000 | 3,000 |
| Eckrant----------------- | Steep Rocky---------------------------- | 1,800 | 1,400 | 800 |
| Oa, Ok*----------------- Oakalla | Loamy Bottomland----------------------- | 5,500 | 4,500 | 2,500 |
| Or*--------------------- Orif | Loamy Bottomland----------------------- | 3,800 | 3,500 | 2,000 |
| PdB--------------------- Pedernales | Tight Sandy Loam----------------------- | 3,500 | 3,000 | 1,500 |
| PuC--------------------- Purves | Shallow-------------------------------- | 3,000 | 2,500 | 1,800 |
| RaD--------------------- Real | Adobe---------------------------------- | 3,500 | 2,500 | 1,500 |
| RcD:* | | | | |
| Real-------------------- | Adobe---------------------------------- | 3,500 | 2,500 | 1,500 |
| Comfort----------------- | Low Stony Hills------------------------ | 3,000 | 2,500 | 1,500 |
| Doss-------------------- | Shallow-------------------------------- | 3,000 | 2,500 | 1,800 |
| RUD:* | | | | |
| Rumple------------------ | Gravelly Redland----------------------- | 3,500 | 3,000 | 2,000 |
| Comfort----------------- | Low Stony Hills------------------------ | 3,000 | 2,500 | 1,500 |
| SeB, SeD---------------- Seawillow | Blackland------------------------------ | 5,000 | 4,500 | 2,500 |
| SuA, SuB---------------- Sunev | Clay Loam------------------------------ | 7,000 | 5,500 | 3,500 |
| TaB--------------------- Tarpley | Redland-------------------------------- | 5,500 | 4,500 | 3,500 |
| Tn---------------------- Tinn | Clayey Bottomland---------------------- | 7,000 | 6,000 | 4,000 |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

| Map symbol and soil name | Camp areas | Picnic areas | Playgrounds | Paths and trails | Golf fairways |
|---|---|---|---|---|---|
| AgC3------------------ Altoga | Slight---------- | Slight---------- | Moderate: slope. | Slight------------ | Moderate: excess lime. |
| AgD3------------------ Altoga | Slight---------- | Slight---------- | Severe: slope. | Slight------------ | Moderate: excess lime. |
| AnA------------------- Anhalt | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: small stones, too clayey. | Moderate: too clayey. | Severe: too clayey. |
| AnB------------------- Anhalt | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: slope, small stones, too clayey. | Moderate: too clayey. | Severe: too clayey. |
| AuB,* AuC3:* | | | | | |
| Austin--------------- | Moderate: too clayey. | Moderate: too clayey. | Moderate: slope, too clayey. | Moderate: too clayey. | Severe: too clayey. |
| Castephen------------ | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Slight------------ | Severe: thin layer. |
| BoB------------------- Boerne | Severe: flooding. | Slight---------- | Slight---------- | Slight------------ | Moderate: excess lime. |
| BrB------------------- Bolar | Slight---------- | Slight---------- | Moderate: small stones, slope. | Slight------------ | Moderate: thin layer. |
| BtD:* | | | | | |
| Brackett------------- | Severe: depth to rock. | Severe: depth to rock. | Severe: small stones, depth to rock. | Slight------------ | Severe: thin layer. |
| Rock outcrop. | | | | | |
| Comfort-------------- | Severe: large stones, small stones, depth to rock. | Severe: large stones, small stones, depth to rock. | Severe: small stones, depth to rock. | Moderate: large stones. | Severe: large stones, thin layer, too clayey. |
| BtG:* | | | | | |
| Brackett------------- | Severe: slope, depth to rock. | Severe: slope, depth to rock. | Severe: slope, small stones, depth to rock. | Moderate: slope. | Severe: slope, thin layer. |
| Rock outcrop. | | | | | |
| Real----------------- | Severe: slope, small stones, depth to rock. | Severe: slope, small stones, depth to rock. | Severe: slope, small stones, depth to rock. | Severe: small stones. | Severe: small stones, slope, thin layer. |
| ByA------------------- Branyon | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: too clayey. | Moderate: too clayey. | Severe: too clayey. |
| ByB------------------- Branyon | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: slope, too clayey. | Moderate: too clayey. | Severe: too clayey. |

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

| Map symbol and soil name | Camp areas | Picnic areas | Playgrounds | Paths and trails | Golf fairways |
|---|---|---|---|---|---|
| CaC3------------------ Castephen | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Slight----------- | Severe: thin layer. |
| CrD:* | | | | | |
| Comfort-------------- | Severe: large stones, small stones, depth to rock. | Severe: large stones, small stones, depth to rock. | Severe: small stones, depth to rock. | Moderate: large stones. | Severe: large stones, thin layer, too clayey. |
| Rock outcrop. | | | | | |
| DeB, DeC3------------- Denton | Moderate: too clayey. | Moderate: too clayey. | Moderate: slope, small stones, too clayey. | Moderate: too clayey. | Severe: too clayey. |
| DoC------------------- Doss | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Moderate: too clayey. | Severe: thin layer. |
| ErG:* | | | | | |
| Eckrant-------------- | Severe: slope, large stones, depth to rock. | Severe: slope, large stones, depth to rock. | Severe: large stones, slope, depth to rock. | Severe: large stones. | Severe: large stones, slope, thin layer. |
| Rock outcrop. | | | | | |
| FeF4------------------ Ferris | Moderate: slope, percs slowly, too clayey. | Moderate: slope, too clayey, percs slowly. | Severe: slope. | Moderate: too clayey. | Severe: too clayey. |
| GrC------------------- Gruene | Severe: cemented pan. | Severe: cemented pan. | Severe: cemented pan. | Moderate: too clayey. | Severe: thin layer, too clayey. |
| HeB, HeC3------------- Heiden | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: slope, too clayey, percs slowly. | Moderate: too clayey. | Severe: too clayey. |
| HeD3------------------ Heiden | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Severe: slope. | Moderate: too clayey. | Severe: too clayey. |
| HgD------------------- Heiden | Moderate: percs slowly, too clayey. | Moderate: percs slowly, too clayey. | Moderate: small stones, too clayey, percs slowly. | Moderate: too clayey. | Severe: small stones, too clayey. |
| HoB------------------- Houston Black | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: slope, too clayey, percs slowly. | Moderate: too clayey. | Severe: too clayey. |
| HvB, HvD-------------- Houston Black | Moderate: small stones, percs slowly, too clayey. | Moderate: too clayey, small stones, percs slowly. | Moderate: slope, too clayey, percs slowly. | Moderate: too clayey. | Severe: too clayey. |
| KrA------------------- Krum | Moderate: too clayey. | Moderate: too clayey. | Moderate: small stones. | Moderate: too clayey. | Severe: too clayey. |
| KrB, KrC-------------- Krum | Moderate: too clayey. | Moderate: too clayey. | Moderate: small stones, slope. | Moderate: too clayey. | Severe: too clayey. |

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

| Map symbol and soil name | Camp areas | Picnic areas | Playgrounds | Paths and trails | Golf fairways |
|---|---|---|---|---|---|
| LeA: Lewisville | Moderate: too clayey. | Moderate: too clayey. | Moderate: too clayey. | Moderate: too clayey. | Severe: too clayey. |
| LeB: Lewisville | Moderate: too clayey. | Moderate: too clayey. | Moderate: slope, too clayey. | Moderate: too clayey. | Severe: too clayey. |
| MEC:* Medlin | Moderate: percs slowly, too clayey. | Moderate: too clayey, percs slowly. | Moderate: slope, too clayey, percs slowly. | Moderate: too clayey. | Severe: too clayey. |
| Eckrant | Severe: large stones, depth to rock. | Severe: large stones, depth to rock. | Severe: large stones, depth to rock. | Severe: large stones. | Severe: large stones, thin layer. |
| MED:* Medlin | Moderate: slope, percs slowly, too clayey. | Moderate: slope, too clayey, percs slowly. | Severe: slope. | Moderate: too clayey. | Severe: too clayey. |
| Eckrant | Severe: slope, large stones, depth to rock. | Severe: slope, large stones, depth to rock. | Severe: large stones, slope, depth to rock. | Severe: large stones. | Severe: large stones, slope, thin layer. |
| Oa: Oakalla | Severe: flooding. | Moderate: too clayey. | Moderate: dusty. | Moderate: dusty. | Moderate: excess lime. |
| Ok*: Oakalla | Severe: flooding. | Moderate: flooding. | Severe: flooding. | Moderate: flooding, dusty. | Severe: flooding. |
| Or*: Orif | Severe: flooding, small stones. | Severe: small stones. | Severe: small stones, flooding. | Moderate: flooding. | Severe: small stones, droughty, flooding. |
| PdB: Pedernales | Slight | Slight | Moderate: slope. | Slight | Slight. |
| Pt. Pits | | | | | |
| PuC: Purves | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Moderate: too clayey. | Severe: thin layer, too clayey. |
| RaD: Real | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Severe: small stones. | Severe: small stones, thin layer. |
| RcD:* Real | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Severe: small stones. | Severe: small stones, thin layer. |
| Comfort | Severe: large stones, small stones, depth to rock. | Severe: large stones, small stones, depth to rock. | Severe: small stones, depth to rock. | Moderate: large stones. | Severe: large stones, thin layer, too clayey. |
| Doss | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Slight | Severe: thin layer. |

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

| Map symbol and soil name | Camp areas | Picnic areas | Playgrounds | Paths and trails | Golf fairways |
|---|---|---|---|---|---|
| RUD:* | | | | | |
| Rumple | Severe: small stones. | Severe: small stones. | Severe: small stones. | Slight | Severe: small stones. |
| Comfort | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Severe: small stones, depth to rock. | Moderate: large stones. | Severe: large stones, thin layer, too clayey. |
| SeB, SeD Seawillow | Slight | Slight | Moderate: slope. | Slight | Slight. |
| SuA Sunev | Slight | Slight | Moderate: small stones. | Slight | Moderate: excess lime. |
| SuB Sunev | Slight | Slight | Moderate: slope, small stones. | Slight | Moderate: excess lime. |
| TaB Tarpley | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Slight | Severe: thin layer, too clayey. |
| Tn Tinn | Severe: flooding, wetness, percs slowly. | Severe: wetness, too clayey, percs slowly. | Severe: too clayey, wetness, flooding. | Severe: wetness, too clayey. | Severe: wetness, flooding, too clayey. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

| Map symbol and soil name | Potential for habitat elements | | | | | | Potential as habitat for-- | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Shrubs | Wetland plants | Shallow water areas | Openland wildlife | Wetland wildlife | Rangeland wildlife |
| AgC3, AgD3---------- Altoga | Fair | Fair | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| AnA, AnB------------ Anhalt | Good | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| AuB,* AuC3:* | | | | | | | | | |
| Austin------------- | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| Castephen---------- | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| BoB---------------- Boerne | Fair | Fair | Good | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| BrB---------------- Bolar | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| BtD:* | | | | | | | | | |
| Brackett----------- | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| Rock outcrop. | | | | | | | | | |
| Comfort------------ | Poor | Poor | Fair | Good | Poor | Very poor | Poor | Very poor | Fair. |
| BtG:* | | | | | | | | | |
| Brackett----------- | Very poor | Very poor | Poor | Fair | Very poor | Very poor | Very poor | Very poor | Poor. |
| Rock outcrop. | | | | | | | | | |
| Real--------------- | Very poor | Very poor | Poor | Fair | Very poor | Very poor | Very poor | Very poor | Poor. |
| ByA, ByB----------- Branyon | Good | Good | Poor | Fair | Poor | Poor | Fair | Poor | Fair. |
| CaC3--------------- Castephen | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| CrD:* | | | | | | | | | |
| Comfort------------ | Poor | Poor | Fair | Good | Poor | Very poor | Poor | Very poor | Fair. |
| Rock outcrop. | | | | | | | | | |
| DeB---------------- Denton | Good | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| DeC3--------------- Denton | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| DoC---------------- Doss | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| ErG:* | | | | | | | | | |
| Eckrant------------ | Very poor | Very poor | Fair | Fair | Very poor | Very poor | Poor | Very poor | Fair. |
| Rock outcrop. | | | | | | | | | |
| FeF4--------------- Ferris | Poor | Fair | Fair | Fair | Very poor | Very poor | Fair | Very poor | Fair. |
| GrC---------------- Gruene | Poor | Poor | Fair | Fair | Poor | Very poor | Poor | Very poor | Fair. |

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

| Map symbol and soil name | Potential for habitat elements: Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Shrubs | Wetland plants | Shallow water areas | Potential as habitat for--: Openland wildlife | Wetland wildlife | Rangeland wildlife |
|---|---|---|---|---|---|---|---|---|---|
| HeB----------------- Heiden | Good | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| HeC3---------------- Heiden | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| HeD3---------------- Heiden | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| HgD----------------- Heiden | Fair | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| HoB, HvB------------ Houston Black | Good | Good | Poor | Fair | Poor | Poor | Fair | Poor | Fair. |
| HvD----------------- Houston Black | Fair | Good | Poor | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| KrA, KrB------------ Krum | Good | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| KrC----------------- Krum | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| LeA, LeB------------ Lewisville | Good | Good | Fair | Fair | Poor | Very poor | Good | Very poor | Fair. |
| MEC:* | | | | | | | | | |
| Medlin------------- | Fair | Fair | Poor | Poor | Very poor | Very poor | Fair | Very poor | Poor. |
| Eckrant------------ | Very poor | Very poor | Fair | Fair | Very poor | Very poor | Poor | Very poor | Fair. |
| MED:* | | | | | | | | | |
| Medlin------------- | Poor | Fair | Poor | Poor | Very poor | Very poor | Poor | Very poor | Poor. |
| Eckrant------------ | Very poor | Very poor | Fair | Fair | Very poor | Very poor | Poor | Very poor | Fair. |
| Oa------------------ Oakalla | Good | Good | Good | Good | Poor | Very poor | Good | Very poor | Good. |
| Ok*----------------- Oakalla | Very poor | Poor | Fair | Good | Poor | Very poor | Poor | Very poor | Fair. |
| Or*----------------- Orif | Poor | Poor | Fair | Good | Poor | Very poor | Fair | Very poor | Fair. |
| PdB----------------- Pedernales | Fair | Good | Good | Good | Poor | Very poor | Good | Very poor | Good. |
| Pt. Pits | | | | | | | | | |
| PuC----------------- Purves | Fair | Good | Poor | Fair | Poor | Very poor | Fair | Very poor | Poor. |
| RaD----------------- Real | Very poor | Poor | Poor | Fair | Poor | Very poor | Poor | Very poor | Poor. |
| RcD:* | | | | | | | | | |
| Real--------------- | Very poor | Poor | Poor | Fair | Poor | Very poor | Poor | Very poor | Poor. |
| Comfort------------ | Poor | Poor | Fair | Good | Poor | Very poor | Poor | Very poor | Fair. |
| Doss--------------- | Fair | Good | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

| Map symbol and soil name | Potential for habitat elements | | | | | | Potential as habitat for-- | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Shrubs | Wetland plants | Shallow water areas | Openland wildlife | Wetland wildlife | Rangeland wildlife |
| RUD:* | | | | | | | | | |
| Rumple | Poor | Poor | Fair | Fair | Poor | Very poor | Poor | Very poor | Fair. |
| Comfort | Poor | Poor | Fair | Good | Poor | Very poor | Poor | Very poor | Fair. |
| SeB Seawillow | Good | Good | Fair | Good | Poor | Very poor | Good | Very poor | Fair. |
| SeD Seawillow | Fair | Good | Fair | Good | Poor | Very poor | Fair | Very poor | Fair. |
| SuA Sunev | Good | Good | Good | Good | Poor | Very poor | Good | Very poor | Good. |
| SuB Sunev | Fair | Good | Good | Good | Poor | Very poor | Good | Very poor | Good. |
| TaB Tarpley | Fair | Fair | Fair | Fair | Poor | Very poor | Fair | Very poor | Fair. |
| Tn Tinn | Poor | Fair | Fair | --- | Poor | Fair | Fair | Poor | Good. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

| Map symbol and soil name | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets | Lawns and landscaping |
|---|---|---|---|---|---|---|
| AgC3, AgD3 Altoga | Moderate: too clayey. | Severe: shrink-swell. | Moderate: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Moderate: excess lime. |
| AnA, AnB Anhalt | Severe: depth to rock, cutbanks cave. | Severe: shrink-swell. | Severe: depth to rock, shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| AuB,* AuC3:* | | | | | | |
| Austin | Moderate: depth to rock, too clayey. | Moderate: shrink-swell. | Moderate: depth to rock, shrink-swell. | Moderate: shrink-swell. | Severe: low strength. | Severe: too clayey. |
| Castephen | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: depth to rock. | Moderate: depth to rock. | Moderate: depth to rock. | Severe: thin layer. |
| BoB Boerne | Slight | Severe: flooding. | Severe: flooding. | Severe: flooding. | Moderate: flooding. | Moderate: excess lime. |
| BrB Bolar | Moderate: depth to rock. | Moderate: shrink-swell. | Moderate: depth to rock, shrink-swell. | Moderate: shrink-swell. | Moderate: low strength, shrink-swell. | Moderate: thin layer. |
| BtD:* | | | | | | |
| Brackett | Severe: depth to rock. | Moderate: depth to rock. | Severe: depth to rock. | Moderate: slope, depth to rock. | Severe: low strength. | Severe: thin layer. |
| Rock outcrop. | | | | | | |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: large stones, thin layer, too clayey. |
| BtG:* | | | | | | |
| Brackett | Severe: depth to rock, slope. | Severe: slope. | Severe: depth to rock, slope. | Severe: slope. | Severe: low strength, slope. | Severe: slope, thin layer. |
| Rock outcrop. | | | | | | |
| Real | Severe: depth to rock, slope. | Severe: slope. | Severe: depth to rock, slope. | Severe: slope. | Severe: slope. | Severe: small stones, slope, thin layer. |
| ByA, ByB Branyon | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| CaC3 Castephen | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: depth to rock. | Moderate: slope, depth to rock. | Moderate: depth to rock. | Severe: thin layer. |
| CrD:* | | | | | | |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: large stones, thin layer, too clayey. |
| Rock outcrop. | | | | | | |

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

| Map symbol and soil name | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets | Lawns and landscaping |
|---|---|---|---|---|---|---|
| DeB, DeC3---------Denton | Moderate: depth to rock, too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| DoC---------------Doss | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: low strength. | Severe: thin layer. |
| ErG:* | | | | | | |
| Eckrant----------- | Severe: depth to rock, large stones, slope. | Severe: slope, depth to rock, large stones. | Severe: depth to rock, slope, large stones. | Severe: slope, depth to rock, large stones. | Severe: depth to rock, slope, large stones. | Severe: large stones, slope, thin layer. |
| Rock outcrop. | | | | | | |
| FeF4--------------Ferris | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell, slope. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| GrC---------------Gruene | Severe: cemented pan. | Moderate: shrink-swell, cemented pan. | Severe: cemented pan. | Moderate: shrink-swell, cemented pan. | Moderate: cemented pan, shrink-swell. | Severe: thin layer, too clayey. |
| HeB, HeC3, HeD3---Heiden | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| HgD---------------Heiden | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: small stones, too clayey. |
| HoB, HvB, HvD-----Houston Black | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| KrA, KrB, KrC-----Krum | Moderate: too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| LeA, LeB----------Lewisville | Moderate: too clayey. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| MEC:* | | | | | | |
| Medlin----------- | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| Eckrant---------- | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: large stones, thin layer. |
| MED:* | | | | | | |
| Medlin----------- | Severe: cutbanks cave. | Severe: shrink-swell. | Severe: shrink-swell. | Severe: shrink-swell, slope. | Severe: low strength, shrink-swell. | Severe: too clayey. |
| Eckrant---------- | Severe: depth to rock, large stones, slope. | Severe: slope, depth to rock, large stones. | Severe: depth to rock, slope, large stones. | Severe: slope, depth to rock, large stones. | Severe: depth to rock, slope, large stones. | Severe: large stones, slope, thin layer. |
| Oa----------------Oakalla | Slight--------- | Severe: flooding. | Severe: flooding. | Severe: flooding. | Severe: low strength. | Moderate: excess lime. |
| Ok*---------------Oakalla | Moderate: flooding. | Severe: flooding. | Severe: flooding. | Severe: flooding. | Severe: low strength, flooding. | Severe: flooding. |

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

| Map symbol and soil name | Shallow excavations | Dwellings without basements | Dwellings with basements | Small commercial buildings | Local roads and streets | Lawns and landscaping |
|---|---|---|---|---|---|---|
| Or*: Orif | Moderate: flooding. | Severe: flooding. | Severe: flooding. | Severe: flooding. | Severe: flooding. | Severe: small stones, droughty, flooding. |
| PdB: Pedernales | Moderate: too clayey. | Moderate: shrink-swell. | Moderate: shrink-swell. | Moderate: shrink-swell. | Severe: low strength. | Slight. |
| Pt. Pits | | | | | | |
| PuC: Purves | Severe: depth to rock. | Severe: shrink-swell, depth to rock. | Severe: depth to rock, shrink-swell. | Severe: shrink-swell, depth to rock. | Severe: depth to rock, low strength, shrink-swell. | Severe: thin layer, too clayey. |
| RaD: Real | Severe: depth to rock. | Moderate: depth to rock. | Severe: depth to rock. | Moderate: slope, depth to rock. | Moderate: depth to rock. | Severe: small stones, thin layer. |
| RcD:* | | | | | | |
| Real | Severe: depth to rock. | Moderate: depth to rock. | Severe: depth to rock. | Moderate: depth to rock, slope. | Moderate: depth to rock. | Severe: small stones, thin layer. |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: large stones, thin layer, too clayey. |
| Doss | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: low strength. | Severe: thin layer. |
| RUD:* | | | | | | |
| Rumple | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Severe: depth to rock. | Moderate: shrink-swell, depth to rock. | Moderate: depth to rock, shrink-swell. | Severe: small stones. |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: large stones, thin layer, too clayey. |
| SeB: Seawillow | Slight | Moderate: shrink-swell. | Slight | Moderate: shrink-swell. | Severe: low strength. | Moderate: excess lime. |
| SeD: Seawillow | Slight | Moderate: shrink-swell. | Slight | Moderate: shrink-swell, slope. | Severe: low strength. | Moderate: excess lime. |
| SuA, SuB: Sunev | Slight | Slight | Slight | Slight | Slight | Moderate: excess lime. |
| TaB: Tarpley | Severe: depth to rock. | Severe: shrink-swell, depth to rock. | Severe: depth to rock, shrink-swell. | Severe: shrink-swell, depth to rock. | Severe: depth to rock, low strength, shrink-swell. | Severe: thin layer, too clayey. |
| Tn: Tinn | Severe: wetness. | Severe: flooding, wetness, shrink-swell. | Severe: flooding, wetness, shrink-swell. | Severe: flooding, wetness, shrink-swell. | Severe: low strength, wetness, flooding. | Severe: wetness, flooding, too clayey. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

| Map symbol and soil name | Septic tank absorption fields | Sewage lagoon areas | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| AgC3, AgD3----------<br>Altoga | Moderate:<br>percs slowly. | Moderate:<br>seepage,<br>slope. | Moderate:<br>too clayey. | Slight----------- | Fair:<br>too clayey,<br>excess lime. |
| AnA, AnB------------<br>Anhalt | Severe:<br>depth to rock,<br>percs slowly. | Severe:<br>depth to rock. | Severe:<br>depth to rock,<br>too clayey. | Severe:<br>depth to rock. | Poor:<br>area reclaim,<br>too clayey,<br>hard to pack. |
| AuB,* AuC3:* | | | | | |
| Austin------------- | Severe:<br>depth to rock,<br>percs slowly. | Severe:<br>depth to rock. | Severe:<br>depth to rock,<br>too clayey. | Severe:<br>depth to rock. | Poor:<br>area reclaim,<br>too clayey,<br>hard to pack. |
| Castephen---------- | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Poor:<br>area reclaim. |
| BoB-----------------<br>Boerne | Moderate:<br>flooding. | Severe:<br>seepage,<br>flooding. | Severe:<br>seepage. | Severe:<br>seepage. | Fair:<br>excess lime. |
| BrB-----------------<br>Bolar | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Poor:<br>area reclaim. |
| BtD:* | | | | | |
| Brackett----------- | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Poor:<br>area reclaim,<br>small stones. |
| Rock outcrop. | | | | | |
| Comfort------------ | Severe:<br>depth to rock,<br>large stones. | Severe:<br>depth to rock,<br>large stones. | Severe:<br>depth to rock,<br>large stones. | Severe:<br>depth to rock. | Poor:<br>too clayey,<br>large stones,<br>thin layer. |
| BtG:* | | | | | |
| Brackett----------- | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Poor:<br>area reclaim,<br>small stones,<br>slope. |
| Rock outcrop. | | | | | |
| Real--------------- | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Severe:<br>depth to rock,<br>slope. | Poor:<br>area reclaim,<br>small stones,<br>slope. |
| ByA-----------------<br>Branyon | Severe:<br>percs slowly. | Slight----------- | Severe:<br>too clayey. | Slight----------- | Poor:<br>too clayey,<br>hard to pack. |
| ByB-----------------<br>Branyon | Severe:<br>percs slowly. | Moderate:<br>slope. | Severe:<br>too clayey. | Slight----------- | Poor:<br>too clayey,<br>hard to pack. |
| CaC3----------------<br>Castephen | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Severe:<br>depth to rock. | Poor:<br>area reclaim. |

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

| Map symbol and soil name | Septic tank absorption fields | Sewage lagoon areas | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| CrD:* | | | | | |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock. | Poor: too clayey, large stones, thin layer. |
| Rock outcrop. | | | | | |
| DeB, DeC3 Denton | Severe: depth to rock, percs slowly. | Severe: depth to rock. | Severe: depth to rock, too clayey. | Severe: depth to rock. | Poor: area reclaim, too clayey, hard to pack. |
| DoC Doss | Severe: depth to rock, percs slowly. | Severe: depth to rock. | Severe: depth to rock, too clayey. | Severe: depth to rock. | Poor: area reclaim, too clayey, hard to pack. |
| ErG:* | | | | | |
| Eckrant | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope. | Poor: area reclaim, large stones, slope. |
| Rock outcrop. | | | | | |
| FeF4 Ferris | Severe: percs slowly. | Severe: slope. | Severe: too clayey. | Moderate: slope. | Poor: too clayey, hard to pack. |
| GrC Gruene | Severe: cemented pan. | Severe: cemented pan. | Moderate: cemented pan. | Severe: cemented pan. | Poor: area reclaim, thin layer. |
| HeB, HeC3, HeD3 Heiden | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| HgD Heiden | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey. |
| HoB, HvB, HvD Houston Black | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| KrA Krum | Severe: percs slowly. | Slight | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| KrB, KrC Krum | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| LeA Lewisville | Moderate: percs slowly. | Moderate: seepage. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| LeB Lewisville | Moderate: percs slowly. | Moderate: seepage, slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| MEC:* | | | | | |
| Medlin | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

| Map symbol and soil name | Septic tank absorption fields | Sewage lagoon areas | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| MEC:* | | | | | |
| Eckrant | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock. | Poor: area reclaim, large stones, thin layer. |
| MED:* | | | | | |
| Medlin | Severe: percs slowly. | Severe: slope. | Severe: too clayey. | Moderate: slope. | Poor: too clayey, hard to pack. |
| Eckrant | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope, large stones. | Severe: depth to rock, slope. | Poor: area reclaim, large stones, slope. |
| Oa: Oakalla | Moderate: flooding. | Moderate: seepage. | Moderate: flooding, too clayey. | Moderate: flooding. | Fair: too clayey, excess lime. |
| Ok*: Oakalla | Severe: flooding. | Severe: flooding. | Severe: flooding. | Severe: flooding. | Fair: too clayey, excess lime. |
| Or*: Orif | Severe: flooding, poor filter. | Severe: seepage, flooding, too sandy. | Severe: flooding, seepage. | Severe: flooding, seepage. | Poor: seepage, too sandy, small stones. |
| PdB: Pedernales | Severe: percs slowly. | Moderate: slope. | Severe: too clayey. | Slight | Poor: too clayey, hard to pack. |
| Pt. Pits | | | | | |
| PuC: Purves | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock, too clayey. | Severe: depth to rock. | Poor: area reclaim, too clayey, hard to pack. |
| RaD: Real | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Poor: area reclaim, small stones. |
| RcD:* | | | | | |
| Real | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Poor: area reclaim, small stones. |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock. | Poor: too clayey, large stones, thin layer. |
| Doss | Severe: depth to rock, percs slowly. | Severe: depth to rock. | Severe: depth to rock, too clayey. | Severe: depth to rock. | Poor: area reclaim, too clayey, hard to pack. |
| RUD:* | | | | | |
| Rumple | Severe: depth to rock, percs slowly. | Severe: depth to rock. | Severe: depth to rock, too clayey. | Severe: depth to rock. | Poor: area reclaim, small stones, thin layer. |

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

| Map symbol and soil name | Septic tank absorption fields | Sewage lagoon areas | Trench sanitary landfill | Area sanitary landfill | Daily cover for landfill |
|---|---|---|---|---|---|
| RUD:* | | | | | |
| Comfort | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock, large stones. | Severe: depth to rock. | Poor: too clayey, large stones, thin layer. |
| SeB, SeD: Seawillow | Slight | Moderate: seepage, slope. | Moderate: too clayey. | Slight | Fair: too clayey, excess lime. |
| SuA: Sunev | Slight | Moderate: seepage. | Moderate: too clayey. | Slight | Fair: too clayey, excess lime. |
| SuB: Sunev | Slight | Moderate: seepage, slope. | Moderate: too clayey. | Slight | Fair: too clayey, excess lime. |
| TaB: Tarpley | Severe: depth to rock, percs slowly. | Severe: depth to rock. | Severe: depth to rock. | Severe: depth to rock. | Poor: area reclaim, too clayey, thin layer. |
| Tn: Tinn | Severe: flooding, wetness, percs slowly. | Severe: flooding. | Severe: flooding, wetness, too clayey. | Severe: flooding, wetness. | Poor: too clayey, hard to pack, wetness. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

| Map symbol and soil name | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| AgC3, AgD3------------ Altoga | Poor: low strength. | Improbable: excess fines. | Improbable: excess fines. | Fair: too clayey, excess lime. |
| AnA, AnB-------------- Anhalt | Poor: area reclaim, low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| AuB,* AuC3:* | | | | |
| Austin---------------- | Poor: area reclaim, low strength. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| Castephen------------ | Poor: area reclaim, low strength, thin layer. | Improbable: excess fines. | Improbable: excess fines. | Poor: area reclaim, thin layer. |
| BoB-------------------- Boerne | Fair: low strength. | Improbable: excess fines. | Improbable: excess fines. | Fair: excess lime. |
| BrB-------------------- Bolar | Poor: area reclaim. | Improbable: excess fines. | Improbable: excess fines. | Poor: small stones. |
| BtD:* | | | | |
| Brackett------------- | Poor: area reclaim, low strength, thin layer. | Improbable: excess fines. | Improbable: excess fines. | Poor: area reclaim, small stones. |
| Rock outcrop. | | | | |
| Comfort-------------- | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, large stones. | Improbable: excess fines, large stones. | Poor: too clayey, large stones, thin layer. |
| BtG:* | | | | |
| Brackett------------- | Poor: area reclaim, low strength, thin layer. | Improbable: excess fines. | Improbable: excess fines. | Poor: area reclaim, small stones, slope. |
| Rock outcrop. | | | | |
| Real------------------ | Poor: area reclaim, thin layer. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, small stones, thin layer. |
| ByA, ByB-------------- Branyon | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| CaC3------------------ Castephen | Poor: area reclaim, low strength, thin layer. | Improbable: excess fines. | Improbable: excess fines. | Poor: area reclaim, thin layer. |

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

| Map symbol and soil name | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| CrD:* | | | | |
| Comfort | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, large stones. | Improbable: excess fines, large stones. | Poor: too clayey, large stones, thin layer. |
| Rock outcrop. | | | | |
| DeB, DeC3 Denton | Poor: area reclaim, low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey, small stones. |
| DoC Doss | Poor: area reclaim, low strength. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, thin layer, excess lime. |
| ErG:* | | | | |
| Eckrant | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, thin layer, large stones. | Improbable: excess fines, thin layer, large stones. | Poor: area reclaim, large stones, thin layer. |
| Rock outcrop. | | | | |
| FeF4 Ferris | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| GrC Gruene | Poor: area reclaim, thin layer. | Improbable: excess fines, thin layer. | Probable | Poor: area reclaim, too clayey, thin layer. |
| HeB, HeC3, HeD3 Heiden | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| HgD Heiden | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey, small stones. |
| HoB Houston Black | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| HvB, HvD Houston Black | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey, small stones. |
| KrA, KrB, KrC Krum | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| LeA, LeB Lewisville | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| MEC,* MED:* | | | | |
| Medlin | Poor: low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey. |
| Eckrant | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, thin layer, large stones. | Improbable: excess fines, thin layer, large stones. | Poor: area reclaim, large stones, thin layer. |

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

| Map symbol and soil name | Roadfill | Sand | Gravel | Topsoil |
|---|---|---|---|---|
| Oa, Ok*: Oakalla | Poor: low strength. | Improbable: excess fines. | Improbable: excess fines. | Fair: too clayey, excess lime. |
| Or*: Orif | Good | Improbable: small stones, excess fines. | Probable | Poor: small stones, area reclaim, excess lime. |
| PdB: Pedernales | Poor: low strength. | Improbable: excess fines. | Improbable: excess fines. | Fair: thin layer. |
| Pt. Pits | | | | |
| PuC: Purves | Poor: area reclaim, low strength, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: area reclaim, too clayey, small stones. |
| RaD: Real | Poor: area reclaim, thin layer. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, small stones, thin layer. |
| RcD:* | | | | |
| Real | Poor: area reclaim, thin layer. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, small stones, thin layer. |
| Comfort | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, large stones. | Improbable: excess fines, large stones. | Poor: too clayey, large stones, thin layer. |
| Doss | Poor: area reclaim, low strength. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, thin layer, excess lime. |
| RUD:* | | | | |
| Rumple | Poor: area reclaim, thin layer. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, too clayey, small stones. |
| Comfort | Poor: area reclaim, thin layer, large stones. | Improbable: excess fines, large stones. | Improbable: excess fines, large stones. | Poor: too clayey, large stones, thin layer. |
| SeB, SeD: Seawillow | Poor: low strength. | Improbable: excess fines. | Improbable: excess fines. | Fair: excess lime. |
| SuA, SuB: Sunev | Good | Improbable: excess fines. | Improbable: excess fines. | Fair: small stones, excess lime. |
| TaB: Tarpley | Poor: area reclaim, low strength, thin layer. | Improbable: excess fines, thin layer. | Improbable: excess fines, thin layer. | Poor: area reclaim, thin layer, too clayey. |
| Tn: Tinn | Poor: low strength, wetness, shrink-swell. | Improbable: excess fines. | Improbable: excess fines. | Poor: too clayey, wetness. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

| Map symbol and soil name | Limitations for-- Pond reservoir areas | Limitations for-- Embankments, dikes, and levees | Features affecting-- Drainage | Features affecting-- Irrigation | Features affecting-- Terraces and diversions | Features affecting-- Grassed waterways |
|---|---|---|---|---|---|---|
| AgC3, AgD3: Altoga | Moderate: seepage. | Moderate: hard to pack. | Deep to water | Slope, excess lime. | Favorable | Excess lime. |
| AnA, AnB: Anhalt | Moderate: depth to rock. | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, depth to rock. | Depth to rock, percs slowly. | Depth to rock, percs slowly. |
| AuB:* | | | | | | |
| Austin | Moderate: depth to rock. | Moderate: thin layer, hard to pack. | Deep to water | Slow intake, depth to rock. | Depth to rock | Depth to rock. |
| Castephen | Severe: depth to rock. | Severe: thin layer. | Deep to water | Depth to rock | Depth to rock | Depth to rock, excess lime. |
| AuC3:* | | | | | | |
| Austin | Moderate: depth to rock. | Moderate: thin layer, hard to pack. | Deep to water | Slow intake, depth to rock, slope. | Depth to rock | Depth to rock. |
| Castephen | Severe: depth to rock. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Depth to rock | Depth to rock, excess lime. |
| BoB: Boerne | Severe: seepage. | Severe: piping. | Deep to water | Excess lime | Favorable | Favorable. |
| BrB: Bolar | Moderate: seepage, depth to rock, slope. | Moderate: thin layer, piping. | Deep to water | Depth to rock, slope. | Depth to rock | Depth to rock. |
| BtD:* | | | | | | |
| Brackett | Severe: depth to rock. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Large stones, depth to rock. | Large stones, depth to rock. |
| Rock outcrop. | | | | | | |
| Comfort | Severe: depth to rock. | Severe: thin layer, hard to pack, large stones. | Deep to water | Large stones, slow intake, depth to rock. | Large stones, depth to rock, percs slowly. | Large stones, depth to rock, percs slowly. |
| BtG:* | | | | | | |
| Brackett | Severe: depth to rock, slope. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Large stones, slope, depth to rock. | Large stones, slope, depth to rock. |
| Rock outcrop. | | | | | | |
| Real | Severe: depth to rock, slope, seepage. | Severe: thin layer, seepage. | Deep to water | Droughty, depth to rock, excess lime. | Slope, depth to rock. | Slope, depth to rock. |
| ByA, ByB: Branyon | Slight | Severe: hard to pack. | Deep to water | Slow intake, percs slowly. | Percs slowly | Percs slowly. |
| CaC3: Castephen | Severe: depth to rock. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Depth to rock | Depth to rock, excess lime. |

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

| Map symbol and soil name | Limitations for-- Pond reservoir areas | Embankments, dikes, and levees | Features affecting-- Drainage | Irrigation | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| CrD:* | | | | | | |
| Comfort | Severe: depth to rock. | Severe: thin layer, hard to pack, large stones. | Deep to water | Large stones, slow intake, depth to rock. | Large stones, depth to rock, percs slowly. | Large stones, depth to rock, percs slowly. |
| Rock outcrop. | | | | | | |
| DeB Denton | Moderate: depth to rock. | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, depth to rock. | Depth to rock, percs slowly. | Depth to rock, percs slowly. |
| DeC3 Denton | Moderate: depth to rock, slope. | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, depth to rock. | Depth to rock, percs slowly. | Depth to rock, percs slowly. |
| DoC Doss | Severe: depth to rock, seepage. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Depth to rock | Depth to rock. |
| ErG:* | | | | | | |
| Eckrant | Severe: depth to rock, seepage. | Severe: thin layer, large stones. | Deep to water | Large stones, droughty, depth to rock. | Slope, large stones, depth to rock. | Large stones, slope, depth to rock. |
| Rock outcrop. | | | | | | |
| FeF4 Ferris | Severe: slope. | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, slope. | Slope, percs slowly. | Slope, percs slowly. |
| GrC Gruene | Severe: seepage, cemented pan. | Severe: thin layer. | Deep to water | Slow intake, cemented pan, slope. | Cemented pan | Cemented pan. |
| HeB Heiden | Slight | Severe: hard to pack. | Deep to water | Slow intake, percs slowly. | Percs slowly | Percs slowly. |
| HeC3, HeD3 Heiden | Slight | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, slope. | Percs slowly | Percs slowly. |
| HgD Heiden | Slight | Severe: hard to pack. | Deep to water | Slow intake, percs slowly. | Percs slowly | Percs slowly. |
| HoB, HvB Houston Black | Slight | Severe: hard to pack. | Deep to water | Slow intake, percs slowly. | Percs slowly | Percs slowly. |
| HvD Houston Black | Moderate: slope. | Severe: hard to pack. | Deep to water | Slow intake, percs slowly, slope. | Percs slowly | Percs slowly. |
| KrA, KrB Krum | Slight | Severe: hard to pack. | Deep to water | Slow intake | Favorable | Favorable. |
| KrC Krum | Moderate: slope. | Severe: hard to pack. | Deep to water | Slow intake, slope. | Favorable | Favorable. |
| LeA, LeB Lewisville | Moderate: seepage. | Moderate: piping, hard to pack. | Deep to water | Slow intake | Erodes easily | Erodes easily. |
| MEC:* | | | | | | |
| Medlin | Slight | Moderate: hard to pack. | Deep to water | Slow intake, percs slowly, slope. | Percs slowly | Percs slowly. |

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

| Map symbol and soil name | Limitations for-- Pond reservoir areas | Embankments, dikes, and levees | Features affecting-- Drainage | Irrigation | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| MEC:* | | | | | | |
| Eckrant | Severe: depth to rock, seepage. | Severe: thin layer, large stones. | Deep to water | Large stones, droughty, depth to rock. | Large stones, depth to rock. | Large stones, depth to rock. |
| MED:* | | | | | | |
| Medlin | Slight | Moderate: hard to pack. | Deep to water | Slow intake, percs slowly, slope. | Slope, percs slowly. | Slope, percs slowly. |
| Eckrant | Severe: depth to rock, seepage. | Severe: thin layer, large stones. | Deep to water | Large stones, droughty, depth to rock. | Slope, large stones, depth to rock. | Large stones, slope, depth to rock. |
| Oa Oakalla | Moderate: seepage. | Moderate: hard to pack. | Deep to water | Excess lime | Favorable | Excess lime. |
| Ok* Oakalla | Moderate: seepage. | Moderate: hard to pack. | Deep to water | Flooding, excess lime. | Flooding | Excess lime. |
| Or* Orif | Severe: seepage. | Severe: seepage. | Deep to water | Droughty, fast intake, flooding. | Small stones | Droughty. |
| PdB Pedernales | Slight | Moderate: hard to pack. | Deep to water | Soil blowing, slope. | Soil blowing | Favorable. |
| Pt. Pits | | | | | | |
| PuC Purves | Severe: depth to rock. | Severe: thin layer. | Deep to water | Slow intake, depth to rock, slope. | Depth to rock | Depth to rock. |
| RaD Real | Severe: depth to rock, seepage. | Severe: thin layer, seepage. | Deep to water | Droughty, depth to rock, excess lime. | Depth to rock | Depth to rock. |
| RcD:* | | | | | | |
| Real | Severe: depth to rock, seepage. | Severe: thin layer, seepage. | Deep to water | Droughty, depth to rock, excess lime. | Depth to rock | Depth to rock. |
| Comfort | Severe: depth to rock. | Severe: thin layer, hard to pack, large stones. | Deep to water | Large stones, slow intake, depth to rock. | Large stones, depth to rock, percs slowly. | Large stones, depth to rock, percs slowly. |
| Doss | Severe: depth to rock, seepage. | Severe: thin layer. | Deep to water | Depth to rock, slope. | Depth to rock | Depth to rock. |
| RUD:* | | | | | | |
| Rumple | Moderate: depth to rock, seepage. | Severe: thin layer. | Deep to water | Percs slowly, depth to rock, slope. | Depth to rock | Depth to rock. |
| Comfort | Severe: depth to rock. | Severe: thin layer, hard to pack, large stones. | Deep to water | Large stones, slow intake, depth to rock. | Large stones, depth to rock, percs slowly. | Large stones, depth to rock, percs slowly. |
| SeB Seawillow | Moderate: seepage. | Moderate: piping. | Deep to water | Favorable | Favorable | Excess lime. |
| SeD Seawillow | Moderate: seepage. | Moderate: piping. | Deep to water | Slope | Favorable | Excess lime. |

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

| Map symbol and soil name | Limitations for-- Pond reservoir areas | Embankments, dikes, and levees | Features affecting-- Drainage | Irrigation | Terraces and diversions | Grassed waterways |
|---|---|---|---|---|---|---|
| SuA: Sunev | Moderate: seepage. | Moderate: piping. | Deep to water | Excess lime | Favorable | Excess lime. |
| SuB: Sunev | Moderate: seepage, slope. | Moderate: piping. | Deep to water | Slope, excess lime. | Favorable | Excess lime. |
| TaB: Tarpley | Severe: depth to rock, seepage. | Severe: thin layer, hard to pack. | Deep to water | Percs slowly, depth to rock. | Depth to rock, percs slowly. | Depth to rock, percs slowly. |
| Tn: Tinn | Slight | Severe: hard to pack, wetness. | Percs slowly, flooding. | Wetness, slow intake, percs slowly. | Wetness, percs slowly. | Wetness, percs slowly. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

| Map symbol and soil name | Depth | USDA texture | Classification | | Fragments > 3 inches | Percentage passing sieve number-- | | | | Liquid limit | Plasticity index |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unified | AASHTO | | 4 | 10 | 40 | 200 | | |
| | In | | | | Pct | | | | | Pct | |
| AgC3, AgD3: Altoga | 0-13 | Silty clay | CL, CH | A-6, A-7-6 | 0 | 95-100 | 95-100 | 90-100 | 70-99 | 33-52 | 17-33 |
| | 13-60 | Silty clay, silty clay loam, clay loam. | CL | A-6, A-7-6 | 0 | 95-100 | 95-100 | 90-100 | 58-99 | 34-48 | 18-33 |
| AnA, AnB: Anhalt | 0-18 | Clay | CH | A-7-6 | 0-10 | 85-100 | 85-100 | 85-100 | 80-100 | 51-70 | 35-53 |
| | 18-28 | Clay | CH | A-7-6 | 0-10 | 85-100 | 85-100 | 85-100 | 80-95 | 68-88 | 45-62 |
| | 28-35 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| AuB,* AuC3:* Austin | 0-11 | Silty clay | CH, CL | A-7-6 | 0-5 | 95-100 | 90-100 | 80-100 | 75-96 | 45-69 | 25-44 |
| | 11-24 | Silty clay, clay, silty clay loam. | CH, CL | A-7-6, A-6 | 0-5 | 95-100 | 90-100 | 80-100 | 75-96 | 35-65 | 16-40 |
| | 24-34 | Weathered bedrock | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Castephen | 0-15 | Clay loam | CL, CH | A-6, A-7-6 | 0-2 | 80-95 | 60-95 | 55-92 | 51-85 | 30-55 | 15-38 |
| | 15-18 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BoB: Boerne | 0-65 | Fine sandy loam | CL, SC, CL-ML, SM-SC | A-4, A-6 | 0-5 | 85-100 | 75-100 | 70-95 | 38-75 | 22-35 | 4-15 |
| BrB: Bolar | 0-14 | Clay loam | CL, SC, CH | A-6, A-7, A-4 | 0-5 | 75-100 | 75-100 | 70-98 | 40-80 | 25-57 | 9-34 |
| | 14-28 | Clay loam, loam, silty clay loam. | CL, SC, CH | A-6, A-7 | 0-10 | 75-98 | 75-95 | 70-90 | 40-80 | 25-60 | 11-38 |
| | 28-30 | Weathered bedrock | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BtD:* Brackett | 0-17 | Gravelly clay loam. | CL, SC, GC | A-6, A-4, A-7-6 | 0-20 | 70-100 | 60-100 | 54-95 | 40-85 | 28-45 | 9-26 |
| | 17-18 | Weathered bedrock | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rock outcrop. | | | | | | | | | | | |
| Comfort | 0-4 | Extremely stony clay. | CH, GC, SC, CL | A-2-7, A-7-6 | 20-70 | 45-98 | 40-98 | 35-95 | 30-90 | 41-65 | 25-45 |
| | 4-11 | Stony clay, very stony clay, extremely stony clay. | CH, GC, SC | A-7-6, A-2-7 | 30-70 | 45-98 | 40-98 | 35-97 | 30-95 | 60-90 | 45-65 |
| | 11-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BtG:* Brackett | 0-14 | Gravelly clay loam. | CL, SC, GC | A-6, A-4, A-7-6 | 0-20 | 70-100 | 60-100 | 54-95 | 40-85 | 28-45 | 9-26 |
| | 14-18 | Weathered bedrock | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rock outcrop. | | | | | | | | | | | |
| Real | 0-12 | Gravelly clay loam. | GC, SC, GP-GC, SP-SC | A-2-6, A-2-4 | 1-10 | 25-75 | 10-50 | 10-45 | 10-35 | 25-35 | 8-15 |
| | 12-36 | Variable, weathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ByA, ByB: Branyon | 0-60 | Clay | CH | A-7-6 | 0 | 95-100 | 85-100 | 80-100 | 75-100 | 54-80 | 35-55 |
| | 60-80 | Clay, silty clay, clay loam. | CH, CL, GC, SC | A-2, A-4, A-6, A-7 | 0-10 | 40-100 | 35-100 | 30-100 | 25-100 | 25-80 | 8-60 |

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

| Map symbol and soil name | Depth | USDA texture | Classification | | Frag- ments > 3 inches | Percentage passing sieve number-- | | | | Liquid limit | Plas- ticity index |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unified | AASHTO | | 4 | 10 | 40 | 200 | | |
| | In | | | | Pct | | | | | Pct | |
| CaC3------------- Castephen | 0-16 | Clay loam-------- | CL, CH | A-6, A-7-6 | 0-2 | 80-95 | 60-95 | 55-92 | 51-85 | 30-55 | 15-38 |
| | 16-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CrD:* | | | | | | | | | | | |
| Comfort--------- | 0-6 | Extremely stony clay. | CH, GC, SC, CL | A-2-7, A-7-6 | 20-70 | 45-98 | 40-98 | 35-95 | 30-90 | 41-65 | 25-45 |
| | 6-13 | Stony clay, very stony clay, extremely stony clay. | CH, GC, SC | A-7-6, A-2-7 | 30-70 | 45-98 | 40-98 | 35-97 | 30-95 | 60-90 | 45-65 |
| | 13-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rock outcrop. | | | | | | | | | | | |
| DeB, DeC3-------- Denton | 0-25 | Silty clay------- | CH, CL | A-7-6 | 0-10 | 80-100 | 80-100 | 80-100 | 75-95 | 49-70 | 26-45 |
| | 25-36 | Silty clay, clay, silty clay loam. | CH, CL | A-7-6 | 0-20 | 80-100 | 80-100 | 80-100 | 70-95 | 41-60 | 21-40 |
| | 36-40 | Weathered bedrock | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DoC-------------- Doss | 0-18 | Silty clay, clay loam. | CL, CH | A-7-6 | 0-20 | 84-100 | 81-100 | 75-100 | 61-95 | 41-61 | 20-39 |
| | 18-24 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ErG:* | | | | | | | | | | | |
| Eckrant--------- | 0-10 | Extremely stony clay. | GC, SC, CH | A-7-6, A-2-7 | 25-75 | 45-98 | 40-98 | 35-97 | 30-94 | 51-76 | 31-54 |
| | 10-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rock outcrop. | | | | | | | | | | | |
| FeF4------------- Ferris | 0-60 | Clay------------- | CH | A-7-6 | 0 | 95-100 | 95-100 | 75-100 | 75-100 | 51-76 | 35-55 |
| GrC-------------- Gruene | 0-13 | Clay------------- | CH, CL | A-7-6, A-6 | 0-5 | 75-98 | 75-95 | 60-90 | 51-80 | 36-55 | 15-31 |
| | 13-22 | Cemented--------- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 22-80 | Variable--------- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HeB, HeC3, HeD3-- Heiden | 0-16 | Clay------------- | CH | A-7-6 | 0 | 95-100 | 90-100 | 80-100 | 75-99 | 51-80 | 32-55 |
| | 16-80 | Clay, shaly clay | CH, CL | A-7-6 | 0 | 90-100 | 90-100 | 75-100 | 70-99 | 50-80 | 32-55 |
| HgD-------------- Heiden | 0-22 | Gravelly clay---- | CH, GC | A-7-6, A-2-7 | 0-10 | 40-80 | 34-75 | 30-75 | 25-75 | 55-80 | 35-55 |
| | 22-80 | Clay, silty clay | CH, CL | A-7-6 | 0 | 83-100 | 81-100 | 75-100 | 70-99 | 45-80 | 31-60 |
| HoB-------------- Houston Black | 0-25 | Clay------------- | CH | A-7-6 | 0 | 94-100 | 94-100 | 94-100 | 85-100 | 58-98 | 34-72 |
| | 25-77 | Clay, silty clay | CH | A-7-6 | 0 | 94-100 | 93-100 | 92-100 | 85-100 | 58-100 | 34-75 |
| HvB, HvD--------- Houston Black | 0-36 | Gravelly clay---- | CH, GC | A-7-6 | 0-5 | 55-80 | 50-75 | 50-75 | 45-75 | 58-90 | 34-65 |
| | 36-60 | Clay, shaly clay | CH | A-7-6 | 0 | 94-100 | 93-100 | 92-100 | 85-100 | 58-100 | 34-75 |
| KrA, KrB, KrC---- Krum | 0-16 | Clay------------- | CH, CL | A-7-6 | 0 | 95-100 | 85-100 | 85-100 | 85-95 | 47-65 | 25-42 |
| | 16-66 | Silty clay, clay | CH | A-7-6 | 0 | 95-100 | 85-100 | 80-100 | 65-95 | 51-74 | 28-50 |
| | 66-80 | Silty clay loam, silty clay, clay. | CH, CL | A-7-6, A-6 | 0 | 85-100 | 75-100 | 70-99 | 65-95 | 36-60 | 20-39 |
| LeA, LeB--------- Lewisville | 0-17 | Silty clay------- | CL, CH | A-7 | 0 | 95-100 | 95-100 | 82-99 | 80-95 | 41-61 | 20-37 |
| | 17-36 | Silty clay, clay loam, silty clay loam. | CL, CH | A-7 | 0 | 95-100 | 95-100 | 73-99 | 72-95 | 40-60 | 24-36 |
| | 36-61 | Silty clay, clay loam, silty clay loam. | CL, CH, SC | A-6, A-7 | 0 | 80-100 | 65-99 | 56-98 | 41-95 | 30-57 | 12-36 |

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

| Map symbol and soil name | Depth | USDA texture | Classification: Unified | Classification: AASHTO | Frag- ments > 3 inches | Percentage passing sieve number-- 4 | 10 | 40 | 200 | Liquid limit | Plas- ticity index |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | In | | | | Pct | | | | | Pct | |
| MEC:* | | | | | | | | | | | |
| Medlin---------- | 0-24 | Clay------------- | CH, CL | A-7-6 | 0 | 90-100 | 85-100 | 85-100 | 80-95 | 48-70 | 25-45 |
| | 24-80 | Clay, silty clay | CL, CH | A-7-6, A-6 | 0 | 90-100 | 85-100 | 75-100 | 70-95 | 35-55 | 15-44 |
| Eckrant--------- | 0-17 | Extremely stony clay. | GC, SC, CH | A-7-6, A-2-7 | 25-75 | 45-98 | 40-98 | 35-97 | 30-94 | 51-76 | 31-54 |
| | 17-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MED:* | | | | | | | | | | | |
| Medlin---------- | 0-6 | Stony clay | CH, CL | A-7-6 | 2-15 | 90-100 | 85-100 | 85-100 | 75-95 | 48-70 | 25-45 |
| | 6-80 | Clay, silty clay | CL, CH | A-7-6, A-6 | 0 | 90-100 | 85-100 | 75-100 | 70-95 | 35-55 | 15-44 |
| Eckrant--------- | 0-16 | Extremely stony clay. | GC, SC | A-7-6 | 25-75 | 45-98 | 40-98 | 35-97 | 80-94 | 51-76 | 31-54 |
| | 16-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Oa--------------- Oakalla | 0-72 | Silty clay loam | CL, CH | A-6, A-7-6 | 0-2 | 85-100 | 80-100 | 70-100 | 64-95 | 25-54 | 14-36 |
| Ok*-------------- Oakalla | 0-80 | Clay loam-------- | CL, CH | A-6, A-7-6 | 0-2 | 85-100 | 80-100 | 70-100 | 64-95 | 25-54 | 14-36 |
| Or*-------------- Orif | 0-20 | Gravelly loamy sand. | GM, GM-GC, SM, SM-SC | A-1-B, A-2-4 | 0-10 | 55-80 | 50-75 | 35-55 | 10-30 | <20 | NP-7 |
| | 20-60 | Stratified very gravelly sand to very gravelly loamy sand. | GW-GM, GM, SW-SM, SM | A-1-A, A-1-B | 0-10 | 11-60 | 5-50 | 5-35 | 5-20 | <20 | NP-4 |
| PdB-------------- Pedernales | 0-12 | Fine sandy loam | SM, ML, CL-ML, SM-SC | A-4, A-2-4 | 0 | 95-100 | 90-100 | 75-100 | 33-55 | <25 | NP-7 |
| | 12-40 | Sandy clay, clay | CH, CL, SC | A-7, A-6 | 0 | 90-100 | 90-100 | 80-100 | 45-75 | 38-60 | 20-36 |
| | 40-45 | Sandy clay loam, clay loam, sandy clay. | SC, CL, CH | A-6, A-7 | 0-5 | 90-100 | 90-100 | 80-100 | 36-75 | 32-55 | 13-30 |
| Pt. Pits | | | | | | | | | | | |
| PuC-------------- Purves | 0-10 | Clay------------- | CH | A-7-6 | 0-5 | 90-100 | 80-100 | 80-95 | 70-95 | 51-65 | 30-40 |
| | 10-19 | Gravelly clay, very gravelly clay, gravelly clay loam. | CH, SC, GC | A-7-6 | 0-35 | 60-100 | 60-100 | 55-95 | 45-90 | 51-65 | 30-40 |
| | 19-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| RaD-------------- Real | 0-9 | Gravelly loam---- | GC, SC, GP-GC, SP-SC | A-2-6, A-2-4 | 1-10 | 25-75 | 10-50 | 10-45 | 10-35 | 25-35 | 8-15 |
| | 9-14 | Variable, weathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| RcD:* | | | | | | | | | | | |
| Real------------ | 0-8 | Gravelly loam. | GC, SC, GP-GC, SP-SC | A-2-6, A-2-4 | 1-10 | 25-75 | 10-50 | 10-45 | 10-35 | 25-35 | 8-15 |
| | 8-15 | Variable, weathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

| Map symbol and soil name | Depth | USDA texture | Classification: Unified | Classification: AASHTO | Frag- ments > 3 inches | Percentage passing sieve number--: 4 | 10 | 40 | 200 | Liquid limit | Plas- ticity index |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | In | | | | Pct | | | | | Pct | |
| RcD:* | | | | | | | | | | | |
| Comfort | 0-6 | Extremely stony clay, very stony clay. | CH, GC, SC, CL | A-2-7, A-7-6 | 20-70 | 45-98 | 40-98 | 35-95 | 30-90 | 41-65 | 25-45 |
| | 6-13 | Stony clay, very stony clay, extremely stony clay. | CH, GC, SC | A-7-6, A-2-7 | 30-70 | 45-98 | 40-98 | 35-97 | 30-95 | 60-90 | 45-65 |
| | 13-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Doss | 0-12 | Clay loam | CL, CH | A-7-6 | 0-20 | 84-100 | 81-100 | 75-100 | 61-95 | 41-61 | 20-39 |
| | 12-24 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| RUD:* | | | | | | | | | | | |
| Rumple | 0-10 | Very cherty clay loam. | GC, CL, SC | A-2-6, A-6 | 0-10 | 40-90 | 35-90 | 35-80 | 25-75 | 30-40 | 13-22 |
| | 10-28 | Very cherty clay, extremely stony clay. | GC, SC | A-2-7 | 0-10 | 20-75 | 13-50 | 13-40 | 13-35 | 41-86 | 20-60 |
| | 28-36 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Comfort | 0-7 | Extremely stony clay. | CH, GC, SC, CL | A-2-7, A-7-6 | 20-70 | 45-98 | 40-98 | 35-95 | 30-90 | 41-65 | 25-45 |
| | 7-12 | Stony clay, very stony clay, extremely stony clay. | CH, GC, SC | A-7-6, A-2-7 | 30-70 | 45-98 | 40-98 | 35-97 | 30-95 | 60-90 | 45-65 |
| | 12-20 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SeB, SeD Seawillow | 0-26 | Clay loam | CL | A-7-6, A-6 | 0-5 | 80-100 | 75-100 | 75-100 | 51-90 | 29-46 | 14-30 |
| | 26-48 | Clay loam, silty clay loam. | CL, ML | A-4, A-6 | 0-5 | 75-100 | 65-100 | 60-100 | 51-75 | 27-41 | 10-25 |
| SuA Sunev | 0-15 | Silty clay loam | CL, SC, CH | A-6, A-7-6 | 0 | 90-100 | 80-100 | 80-100 | 60-80 | 30-51 | 12-32 |
| | 15-33 | Loam, clay loam, silty clay loam. | CL | A-4, A-6 | 0 | 85-100 | 80-100 | 70-100 | 51-85 | 28-40 | 8-20 |
| | 33-65 | Loam, clay loam, silty clay loam. | CL | A-4, A-6 | 0 | 80-100 | 70-100 | 65-100 | 51-61 | 25-40 | 8-20 |
| SuB Sunev | 0-11 | Clay loam | CL, SC, CH | A-6, A-7-6 | 0 | 90-100 | 80-100 | 80-100 | 60-80 | 30-51 | 12-32 |
| | 11-35 | Loam, clay loam, silty clay loam. | CL | A-4, A-6 | 0 | 85-100 | 80-100 | 70-100 | 51-85 | 28-40 | 8-20 |
| | 35-60 | Loam, clay loam, silty clay loam. | CL | A-4, A-6 | 0 | 80-100 | 70-100 | 65-100 | 51-61 | 25-40 | 8-20 |
| TaB Tarpley | 0-6 | Clay | CL, CH | A-7 | 0-3 | 90-100 | 90-100 | 80-95 | 70-90 | 41-60 | 20-38 |
| | 6-17 | Clay | CH | A-7 | 0 | 90-100 | 90-100 | 90-100 | 65-98 | 51-80 | 30-55 |
| | 17-21 | Unweathered bedrock. | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tn Tinn | 0-25 | Clay | CH, CL | A-7 | 0 | 95-100 | 95-100 | 85-100 | 80-100 | 45-75 | 25-54 |
| | 25-80 | Clay, silty clay | CH | A-7 | 0 | 95-100 | 90-100 | 80-100 | 80-100 | 55-75 | 35-54 |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

| Map symbol and soil name | Depth | Clay | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Erosion factors K | Erosion factors T | Organic matter |
|---|---|---|---|---|---|---|---|---|---|
| | In | Pct | In/hr | In/in | pH | | | | Pct |
| AgC3, AgD3-------- | 0-13 | 35-50 | 0.6-2.0 | 0.15-0.18 | 7.9-8.4 | High------------ | 0.32 | 5 | <2 |
| Altoga | 13-60 | 35-50 | 0.6-2.0 | 0.15-0.18 | 7.9-8.4 | Moderate-------- | 0.32 | | |
| AnA, AnB---------- | 0-18 | --- | <0.06 | 0.15-0.18 | 6.1-8.4 | High------------ | 0.32 | 2 | --- |
| Anhalt | 18-28 | --- | <0.06 | 0.15-0.18 | 6.1-8.4 | Very high------- | 0.32 | | |
| | 28-35 | --- | --- | --- | --- | --------------- | ---- | | |
| AuB,* AuC3:* | | | | | | | | | |
| Austin----------- | 0-11 | 35-55 | 0.2-0.6 | 0.15-0.20 | 7.9-8.4 | High------------ | 0.32 | 2 | 1-4 |
| | 11-24 | 35-55 | 0.2-0.6 | 0.15-0.20 | 7.9-8.4 | Moderate-------- | 0.32 | | |
| | 24-34 | --- | --- | --- | --- | --------------- | ---- | | |
| Castephen-------- | 0-15 | 24-43 | 0.6-2.0 | 0.08-0.14 | 7.9-8.4 | Moderate-------- | 0.32 | 1 | 1-3 |
| | 15-18 | --- | --- | --- | --- | --------------- | ---- | | |
| BoB--------------- | 0-65 | 12-23 | 2.0-6.0 | 0.10-0.15 | 7.9-8.4 | Low------------- | 0.28 | 5 | .5-1 |
| Boerne | | | | | | | | | |
| BrB--------------- | 0-14 | 25-40 | 0.6-2.0 | 0.11-0.20 | 7.9-8.4 | Moderate-------- | 0.32 | 2 | 1-3 |
| Bolar | 14-28 | 25-40 | 0.6-2.0 | 0.11-0.20 | 7.9-8.4 | Moderate-------- | 0.17 | | |
| | 28-30 | --- | --- | --- | --- | --------------- | ---- | | |
| BtD:* | | | | | | | | | |
| Brackett--------- | 0-17 | 15-35 | 0.2-0.6 | 0.10-0.20 | 7.9-8.4 | Low------------- | 0.17 | 2 | <1 |
| | 17-18 | --- | --- | --- | --- | --------------- | ---- | | |
| Rock outcrop. | | | | | | | | | |
| Comfort---------- | 0-4 | 35-50 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Low------------- | 0.10 | 1 | 1-4 |
| | 4-11 | 55-75 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Moderate-------- | 0.10 | | |
| | 11-20 | --- | --- | --- | --- | --------------- | ---- | | |
| BtG:* | | | | | | | | | |
| Brackett--------- | 0-14 | 15-35 | 0.2-0.6 | 0.10-0.20 | 7.9-8.4 | Low------------- | 0.17 | 2 | <1 |
| | 14-18 | --- | --- | --- | --- | --------------- | ---- | | |
| Rock outcrop. | | | | | | | | | |
| Real------------- | 0-12 | 22-40 | 0.6-2.0 | 0.05-0.10 | 7.9-8.4 | Low------------- | 0.10 | 1 | 1-4 |
| | 12-36 | --- | --- | --- | --- | --------------- | ---- | | |
| ByA, ByB---------- | 0-60 | 45-60 | <0.06 | 0.15-0.18 | 7.9-8.4 | Very high------- | 0.32 | 5 | 2-4 |
| Branyon | 60-80 | 30-60 | <2.0 | 0.11-0.18 | 7.9-8.4 | Very high------- | 0.32 | | |
| CaC3-------------- | 0-16 | 24-43 | 0.6-2.0 | 0.08-0.14 | 7.9-8.4 | Moderate-------- | 0.32 | 1 | 1-3 |
| Castephen | 16-20 | --- | --- | --- | --- | --------------- | ---- | | |
| CrD:* | | | | | | | | | |
| Comfort---------- | 0-6 | 35-50 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Low------------- | 0.10 | 1 | 1-4 |
| | 6-13 | 55-75 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Moderate-------- | 0.10 | | |
| | 13-20 | --- | --- | --- | --- | --------------- | ---- | | |
| Rock outcrop. | | | | | | | | | |
| DeB, DeC3--------- | 0-25 | 35-60 | 0.06-0.2 | 0.15-0.20 | 7.9-8.4 | High------------ | 0.32 | 2 | 1-4 |
| Denton | 25-36 | 35-60 | 0.06-0.2 | 0.15-0.20 | 7.9-8.4 | High------------ | 0.32 | | |
| | 36-40 | --- | --- | --- | --- | --------------- | ---- | | |
| DoC--------------- | 0-18 | 32-48 | 0.2-0.6 | 0.15-0.20 | 7.9-8.4 | Moderate-------- | 0.24 | 1 | 1-3 |
| Doss | 18-24 | --- | --- | --- | --- | --------------- | ---- | | |

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

| Map symbol and soil name | Depth | Clay | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Erosion factors K | Erosion factors T | Organic matter |
|---|---|---|---|---|---|---|---|---|---|
| | In | Pct | In/hr | In/in | pH | | | | Pct |
| ErG:* | | | | | | | | | |
| Eckrant | 0-10 | 35-60 | 0.2-0.6 | 0.05-0.12 | 6.6-8.4 | Moderate | 0.10 | 1 | --- |
| | 10-20 | --- | --- | --- | --- | --- | ---- | | |
| Rock outcrop. | | | | | | | | | |
| FeF4 Ferris | 0-60 | 40-60 | <0.06 | 0.15-0.18 | 7.9-8.4 | Very high | 0.32 | 4 | .5-2 |
| GrC Gruene | 0-13 | 35-50 | 0.2-0.6 | 0.12-0.18 | 6.6-8.4 | Moderate | 0.28 | 1 | 1-3 |
| | 13-22 | --- | --- | --- | --- | --- | ---- | | |
| | 22-80 | --- | --- | --- | --- | --- | ---- | | |
| HeB, HeC3, HeD3 Heiden | 0-22 | 40-60 | <0.06 | 0.15-0.20 | 7.9-8.4 | Very high | 0.32 | 5 | 1-4 |
| | 22-80 | 40-60 | <0.06 | 0.12-0.20 | 7.9-8.4 | Very high | 0.32 | | |
| HgD Heiden | 0-16 | 40-60 | <0.06 | 0.09-0.18 | 7.9-8.4 | Very high | 0.20 | 5 | 1-3 |
| | 16-80 | 40-60 | <0.06 | 0.12-0.20 | 7.9-8.4 | Very high | 0.32 | | |
| HoB Houston Black | 0-25 | 40-60 | <0.06 | 0.15-0.20 | 7.4-8.4 | Very high | 0.32 | 5 | 1-4 |
| | 25-77 | 40-60 | <0.06 | 0.15-0.20 | 7.4-8.4 | Very high | 0.32 | | |
| HvB, HvD Houston Black | 0-36 | 40-60 | <0.06 | 0.11-0.18 | 7.4-8.4 | High | 0.20 | 5 | 1-4 |
| | 36-60 | 40-60 | <0.06 | 0.15-0.20 | 7.4-8.4 | Very high | 0.32 | | |
| KrA, KrB, KrC Krum | 0-16 | 35-55 | 0.2-0.6 | 0.15-0.20 | 7.4-8.4 | High | 0.32 | 5 | 1-3 |
| | 16-66 | 40-60 | 0.2-0.6 | 0.14-0.20 | 7.9-8.4 | High | 0.32 | | |
| | 66-80 | 35-60 | 0.2-0.6 | 0.14-0.20 | 7.9-8.4 | High | 0.32 | | |
| LeA, LeB Lewisville | 0-17 | 28-45 | 0.6-2.0 | 0.16-0.20 | 7.9-8.4 | High | 0.32 | 5 | 1-3 |
| | 17-36 | 30-45 | 0.6-2.0 | 0.14-0.18 | 7.9-8.4 | High | 0.37 | | |
| | 36-61 | 30-50 | 0.6-2.0 | 0.14-0.18 | 7.9-8.4 | High | 0.37 | | |
| MEC:* | | | | | | | | | |
| Medlin | 0-24 | 40-60 | <0.06 | 0.12-0.18 | 7.4-8.4 | High | 0.32 | 4 | .5-2 |
| | 24-80 | 40-60 | <0.06 | 0.12-0.18 | 7.4-8.4 | High | 0.32 | | |
| Eckrant | 0-17 | 35-60 | 0.2-0.6 | 0.05-0.12 | 6.6-8.4 | Moderate | 0.10 | 1 | --- |
| | 17-20 | --- | --- | --- | --- | --- | ---- | | |
| MED:* | | | | | | | | | |
| Medlin | 0-6 | 40-60 | <0.06 | 0.10-0.18 | 7.4-8.4 | High | 0.20 | 4 | .5-2 |
| | 6-80 | 40-60 | <0.06 | 0.12-0.18 | 7.4-8.4 | High | 0.32 | | |
| Eckrant | 0-16 | 35-60 | 0.2-0.6 | 0.05-0.12 | 6.6-8.4 | Moderate | 0.10 | 1 | --- |
| | 16-20 | --- | --- | --- | --- | --- | ---- | | |
| Oa, Ok* Oakalla | 0-80 | 25-43 | 0.6-2.0 | 0.12-0.19 | 7.9-8.4 | Moderate | 0.32 | 5 | 1-3 |
| Or* Orif | 0-20 | --- | 6.0-20 | 0.03-0.08 | 7.9-8.4 | Low | 0.10 | 5 | --- |
| | 20-60 | --- | 6.0-20 | 0.03-0.08 | 7.9-8.4 | Low | 0.10 | | |
| PdB Pedernales | 0-12 | 5-20 | 0.6-2.0 | 0.12-0.17 | 6.1-7.8 | Low | 0.32 | 5 | <1 |
| | 12-40 | 35-55 | 0.2-0.6 | 0.15-0.20 | 6.1-7.8 | Moderate | 0.28 | | |
| | 40-45 | 20-50 | 0.2-0.6 | 0.15-0.20 | 7.9-8.4 | Moderate | 0.28 | | |
| Pt. Pits | | | | | | | | | |
| PuC Purves | 0-10 | 35-55 | 0.2-0.6 | 0.12-0.18 | 7.9-8.4 | High | 0.32 | 1 | 1-3 |
| | 10-19 | 35-55 | 0.2-0.6 | 0.08-0.18 | 7.9-8.4 | High | 0.32 | | |
| | 19-20 | --- | --- | --- | --- | --- | ---- | | |
| RaD Real | 0-9 | 22-40 | 0.6-2.0 | 0.05-0.10 | 7.9-8.4 | Low | 0.10 | 1 | 1-4 |
| | 9-14 | --- | --- | --- | --- | --- | ---- | | |

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

| Map symbol and soil name | Depth | Clay | Permeability | Available water capacity | Soil reaction | Shrink-swell potential | Erosion factors K | Erosion factors T | Organic matter |
|---|---|---|---|---|---|---|---|---|---|
| | In | Pct | In/hr | In/in | pH | | | | Pct |
| RcD:* | | | | | | | | | |
| Real------------- | 0-8 | 22-40 | 0.6-2.0 | 0.05-0.10 | 7.9-8.4 | Low------------ | 0.10 | 1 | 1-4 |
| | 8-15 | --- | --- | --- | --- | --------------- | ---- | | |
| Comfort---------- | 0-6 | 35-50 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Low------------ | 0.10 | 1 | 1-4 |
| | 6-13 | 55-75 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Moderate------- | 0.10 | | |
| | 13-20 | --- | --- | --- | --- | --------------- | ---- | | |
| Doss------------- | 0-12 | 32-48 | 0.2-0.6 | 0.15-0.20 | 7.9-8.4 | Moderate------- | 0.24 | 1 | 1-3 |
| | 12-24 | --- | --- | --- | --- | --------------- | ---- | | |
| RUD:* | | | | | | | | | |
| Rumple----------- | 0-10 | 20-40 | 0.2-0.6 | 0.08-0.16 | 6.1-7.8 | Low------------ | 0.17 | 2 | 1-3 |
| | 10-28 | 40-80 | 0.2-0.6 | 0.05-0.15 | 6.1-8.4 | Moderate------- | 0.10 | | |
| | 28-36 | --- | --- | --- | --- | --------------- | ---- | | |
| Comfort---------- | 0-7 | 35-50 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Low------------ | 0.10 | 1 | 1-4 |
| | 7-12 | 55-75 | 0.06-0.2 | 0.07-0.15 | 6.6-8.4 | Moderate------- | 0.10 | | |
| | 12-20 | --- | --- | --- | --- | --------------- | ---- | | |
| SeB, SeD---------- Seawillow | 0-26 | 27-40 | 0.6-2.0 | 0.12-0.20 | 7.9-8.4 | Moderate------- | 0.32 | 5 | <1 |
| | 26-48 | --- | 0.6-2.0 | 0.12-0.18 | 7.9-8.4 | Low------------ | 0.32 | | |
| SuA, SuB---------- Sunev | 0-15 | 20-40 | 0.6-2.0 | 0.11-0.16 | 7.9-8.4 | Low------------ | 0.28 | 5 | 1-3 |
| | 15-33 | 20-40 | 0.6-2.0 | 0.11-0.16 | 7.9-8.4 | Low------------ | 0.28 | | |
| | 33-65 | 20-40 | 0.6-2.0 | 0.11-0.16 | 7.9-8.4 | Low------------ | 0.28 | | |
| TaB--------------- Tarpley | 0-6 | 30-50 | 0.2-0.6 | 0.15-0.20 | 6.1-7.8 | High----------- | 0.32 | 1 | 1-4 |
| | 6-17 | 60-80 | 0.06-0.2 | 0.12-0.18 | 6.1-7.8 | Very high------ | 0.32 | | |
| | 17-21 | --- | --- | --- | --- | --------------- | ---- | | |
| Tn---------------- Tinn | 0-25 | 35-60 | 0.06-0.2 | 0.15-0.20 | 7.4-8.4 | High----------- | 0.32 | 5 | 1-4 |
| | 25-80 | 40-60 | <0.06 | 0.15-0.20 | 7.4-8.4 | High----------- | 0.32 | | |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and terms such as "rare," "brief," and "frequent" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

| Map symbol and soil name | Hydro-logic group | Flooding: Frequency | Flooding: Duration | Flooding: Months | Bedrock: Depth | Bedrock: Hardness | Cemented pan: Depth | Cemented pan: Hardness | Risk of corrosion: Uncoated steel | Risk of corrosion: Concrete |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | In | | In | | | |
| AgC3, AgD3 Altoga | C | None | --- | --- | >60 | --- | --- | --- | High | Low. |
| AnA, AnB Anhalt | D | None | --- | --- | 20-40 | Hard | --- | --- | High | Low. |
| AuB,* AuC3:* | | | | | | | | | | |
| Austin | C | None | --- | --- | 20-40 | Soft | --- | --- | High | Low. |
| Castephen | C | None | --- | --- | 8-20 | Soft | --- | --- | High | Low. |
| BoB Boerne | B | Rare | --- | --- | >60 | --- | --- | --- | Moderate | Low. |
| BrB Bolar | C | None | --- | --- | 25-40 | Soft | --- | --- | High | Low. |
| BtD:* | | | | | | | | | | |
| Brackett | C | None | --- | --- | 11-20 | Soft | --- | --- | High | Low. |
| Rock outcrop. | | | | | | | | | | |
| Comfort | D | None | --- | --- | 9-20 | Hard | --- | --- | High | Low. |
| BtG:* | | | | | | | | | | |
| Brackett | C | None | --- | --- | 11-20 | Soft | --- | --- | High | Low. |
| Rock outcrop. | | | | | | | | | | |
| Real | D | None | --- | --- | 8-16 | Soft | --- | --- | High | Low. |
| ByA, ByB Branyon | D | None | --- | --- | >60 | --- | --- | --- | High | Low. |
| CaC3 Castephen | C | None | --- | --- | 8-20 | Soft | --- | --- | High | Low. |
| CrD:* | | | | | | | | | | |
| Comfort | D | None | --- | --- | 9-20 | Hard | --- | --- | High | Low. |
| Rock outcrop. | | | | | | | | | | |
| DeB, DeC3 Denton | D | None | --- | --- | 24-40 | Soft | --- | --- | High | Low. |
| DoC Doss | C | None | --- | --- | 11-20 | Soft | --- | --- | High | Low. |
| ErG:* | | | | | | | | | | |
| Eckrant | D | None | --- | --- | 4-20 | Hard | --- | --- | High | Low. |
| Rock outcrop. | | | | | | | | | | |
| FeF4 Ferris | D | None | --- | --- | >60 | --- | --- | --- | High | Low. |
| GrC Gruene | D | None | --- | --- | >60 | --- | 7-16 | Thin | High | Low. |
| HeB, HeC3, HeD3, HgD Heiden | D | None | --- | --- | >60 | --- | --- | --- | High | Low. |

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

| Map symbol and soil name | Hydro-logic group | Flooding | | | Bedrock | | Cemented pan | | Risk of corrosion | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | Duration | Months | Depth | Hardness | Depth | Hardness | Uncoated steel | Concrete |
| | | | | | In | | In | | | |
| HoB, HvB, HvD----- Houston Black | D | None-------- | --- | --- | >60 | --- | --- | --- | High----- | Low. |
| KrA, KrB, KrC----- Krum | D | None-------- | --- | --- | >60 | --- | --- | --- | High----- | Low. |
| LeA, LeB---------- Lewisville | B | None-------- | --- | --- | >60 | --- | --- | --- | High----- | Low. |
| MEC,* MED:* | | | | | | | | | | |
| Medlin----------- | D | None-------- | --- | --- | >60 | --- | --- | --- | High----- | Low. |
| Eckrant---------- | D | None-------- | --- | --- | 4-20 | Hard | --- | --- | High----- | Low. |
| Oa---------------- Oakalla | B | Rare-------- | --- | --- | >60 | --- | --- | --- | Moderate | Low. |
| Ok*--------------- Oakalla | B | Frequent---- | Very brief to brief. | May-Sep | >60 | --- | --- | --- | Moderate | Low. |
| Or*--------------- Orif | A | Frequent---- | Very brief | Sep-Jun | >60 | --- | --- | --- | Low------- | Low. |
| PdB--------------- Pedernales | C | None-------- | --- | --- | >60 | --- | --- | --- | High----- | Low. |
| Pt. Pits | | | | | | | | | | |
| PuC--------------- Purves | D | None-------- | --- | --- | 8-20 | Hard | --- | --- | High----- | Low. |
| RaD--------------- Real | D | None-------- | --- | --- | 8-16 | Soft | --- | --- | High----- | Low. |
| RcD:* | | | | | | | | | | |
| Real------------- | D | None-------- | --- | --- | 8-16 | Soft | --- | --- | High----- | Low. |
| Comfort---------- | D | None-------- | --- | --- | 9-20 | Hard | --- | --- | High----- | Low. |
| Doss------------- | C | None-------- | --- | --- | 11-20 | Soft | --- | --- | High----- | Low. |
| RUD:* | | | | | | | | | | |
| Rumple----------- | C | None-------- | --- | --- | 20-40 | Hard | --- | --- | High----- | Low. |
| Comfort---------- | D | None-------- | --- | --- | 9-20 | Hard | --- | --- | High----- | Low. |
| SeB, SeD---------- Seawillow | B | None-------- | --- | --- | >60 | --- | --- | --- | Moderate | Low. |
| SuA, SuB---------- Sunev | B | None-------- | --- | --- | >60 | --- | --- | --- | Moderate | Low. |
| TaB--------------- Tarpley | D | None-------- | --- | --- | 13-20 | Hard | --- | --- | High----- | Low. |
| Tn---------------- Tinn | D | Frequent---- | Brief----- | Feb-May | >60 | --- | --- | --- | High----- | Low. |

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX TEST DATA

| Soil name, report number, horizon, and depth in inches | Classification | | Grain size distribution | | | | | | | | | Liquid limit[2] | Plasticity index[2] | Specific gravity | Shrinkage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Percentage passing sieve[1]-- | | | | | | Percentage smaller than-- | | | | | | | | |
| | AASHTO | Unified | 5/8 inch | 3/8 inch | No. 4 | No. 10 | No. 40 | No. 200 | .05 mm | .005 mm | .002 mm | | | | Limit | Linear | Ratio |
| | | | | | | | | | | | | Pct | | G/cc | Pct | Pct | Pct |
| Altoga silty clay:[3] (S72TX-105-002) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 6 | A-6 (12) | CL | -- | 100 | 99 | 99 | 97 | 78 | 66 | 37 | 26 | 33 | 17 | 2.66 | 15.0 | 8.9 | 1.85 |
| B2------- 6 to 38 | A-6 (20) | CL | -- | 100 | 100 | 100 | 99 | 90 | 85 | 55 | 38 | 40 | 22 | 2.66 | 17.0 | 11.0 | 1.82 |
| C--------38 to 55 | A-6 (21) | CL | -- | 100 | 100 | 99 | 98 | 87 | 79 | 52 | 36 | 40 | 25 | 2.67 | 15.0 | 12.0 | 1.82 |
| Boerne fine sandy loam:[4] (S79TX-209-002) | | | | | | | | | | | | | | | | | |
| A--------- 5 to 17 | A-4 (00) | SM-SC | -- | 100 | 100 | 100 | 94 | 38 | 27 | 15 | 9 | 25 | 6 | 2.66 | 17.0 | 4.6 | 1.81 |
| B22ca----26 to 41 | A-4 (01) | SC | -- | 100 | 100 | 100 | 93 | 43 | 33 | 18 | 14 | 26 | 8 | 2.70 | 18.0 | 4.3 | 1.82 |
| Cca------41 to 65 | A-6 (02) | SC | -- | 100 | 100 | 100 | 92 | 49 | 39 | 19 | 11 | 28 | 11 | 2.71 | 17.0 | 6.2 | 1.85 |
| Bolar clay loam:[5] (S79TX-209-003) | | | | | | | | | | | | | | | | | |
| A12------ 5 to 14 | A-7-6(27) | CH | 100 | 99 | 98 | 94 | 84 | 77 | 57 | 35 | 23 | 57 | 34 | 2.70 | 14.0 | 17.8 | 1.87 |
| B2ca-----14 to 28 | A-7-6(32) | CH | 100 | 99 | 97 | 95 | 84 | 79 | 55 | 37 | 23 | 59 | 38 | 2.70 | 14.0 | 18.4 | 1.87 |
| Branyon clay:[6] (S72TX-105-005) | | | | | | | | | | | | | | | | | |
| A11------ 0 to 24 | A-7-6(50) | CH | 100 | 100 | 100 | 100 | 98 | 96 | 92 | 63 | 50 | 68 | 46 | 2.69 | 12.0 | 22.3 | 2.01 |
| A12------24 to 30 | A-7-6(52) | CH | 100 | 100 | 100 | 99 | 98 | 97 | 95 | 71 | 57 | 68 | 48 | 2.74 | 12.0 | 22.3 | 2.01 |
| AC-------30 to 75 | A-7-6(53) | CH | 100 | 100 | 100 | 99 | 97 | 96 | 93 | 67 | 53 | 70 | 49 | 2.76 | 13.0 | 22.4 | 2.00 |
| Ferris clay:[7] (S78TX-091-001) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 12 | A-7-6(51) | CH | 100 | 100 | 100 | 100 | 100 | 100 | 98 | 76 | 62 | 65 | 45 | 2.71 | 12.0 | 21.4 | 1.99 |
| AC1------12 to 24 | A-7-6(51) | CH | 100 | 100 | 100 | 99 | 95 | 94 | 92 | 73 | 61 | 68 | 48 | 2.77 | 12.0 | 22.2 | 2.01 |
| C2-------41 to 60 | A-7-6(54) | CH | 100 | 100 | 100 | 100 | 99 | 99 | 97 | 75 | 63 | 67 | 48 | 2.74 | 14.0 | 20.9 | 1.93 |
| Krum clay:[8] (S72TX-105-002) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 24 | A-7-6(42) | CH | 100 | 100 | 99 | 97 | 96 | 94 | 89 | 58 | 48 | 61 | 40 | 2.68 | 14.0 | 19.8 | 1.97 |
| B2-------24 to 54 | A-7-6(36) | CH | 100 | 99 | 96 | 92 | 90 | 87 | 83 | 60 | 50 | 59 | 39 | 2.72 | 13.0 | 19.6 | 2.00 |
| Lewisville silty clay:[9] (S78TX-209-001) | | | | | | | | | | | | | | | | | |
| A11------ 5 to 18 | A-7-6(37) | CH | 100 | 100 | 100 | 100 | 99 | 93 | 89 | 54 | 38 | 59 | 34 | 2.65 | 17.0 | 17.8 | 1.85 |
| B21ca----28 to 38 | A-6 (19) | CL | 100 | 100 | 99 | 98 | 96 | 80 | 79 | 49 | 36 | 40 | 24 | 2.68 | 15.0 | 11.9 | 1.89 |
| Lewisville silty clay:[10] (S79TX-209-004) | | | | | | | | | | | | | | | | | |
| A1------- 7 to 17 | A-7-6(36) | CH | 100 | 100 | 100 | 100 | 99 | 94 | 86 | 52 | 37 | 57 | 33 | 2.64 | 15.0 | 17.7 | 1.89 |
| B21ca----17 to 36 | A-7-6(36) | CH | 100 | 100 | 100 | 100 | 99 | 93 | 87 | 58 | 46 | 56 | 35 | 2.64 | 13.0 | 18.8 | 1.99 |
| B22ca----36 to 54 | A-7-6(36) | CH | 100 | 100 | 99 | 97 | 96 | 90 | 83 | 58 | 47 | 57 | 36 | 2.62 | 13.0 | 19.0 | 2.01 |
| Cca------54 to 61 | A-7-6(19) | CH | 98 | 89 | 80 | 75 | 72 | 64 | 42 | 29 | 8 | 51 | 32 | 2.66 | 14.0 | 16.8 | 1.96 |
| Medlin stony clay:[11] (S78TX-091-002) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 8 | A-7-6(22) | CL | 100 | 99 | 97 | 93 | 87 | 82 | 77 | 50 | 37 | 48 | 26 | 2.63 | 12.0 | 16.0 | 1.94 |
| AC1------ 8 to 30 | A-7-6(29) | CL | 100 | 100 | 98 | 96 | 94 | 92 | 91 | 68 | 53 | 45 | 29 | 2.71 | 11.0 | 16.0 | 2.03 |
| C2-------38 to 50 | A-7-6(32) | CH | 100 | 100 | 97 | 91 | 77 | 72 | 71 | 56 | 48 | 65 | 44 | 2.80 | 16.0 | 19.3 | 1.86 |
| Medlin clay:[12] (S72TX-105-003) | | | | | | | | | | | | | | | | | |
| A--------- 0 to 4 | A-7-6(31) | CH | 97 | 95 | 92 | 89 | 85 | 81 | 80 | 58 | 48 | 57 | 37 | 2.73 | 16.0 | 16.8 | 1.84 |
| AC------- 4 to 60 | A-7-6(24) | CH | 100 | 99 | 97 | 91 | 80 | 72 | 70 | 50 | 43 | 55 | 35 | 2.77 | 16.0 | 16.5 | 1.88 |

See footnotes at end of table.

TABLE 16.--ENGINEERING INDEX TEST DATA--Continued

| Soil name, report number, horizon, and depth in inches | Classification: AASHTO | Classification: Unified | Percentage passing sieve[1]--: 5/8 inch | 3/8 inch | No. 4 | No. 10 | No. 40 | No. 200 | Percentage smaller than--: .05 mm | .005 mm | .002 mm | Liquid limit[2] | Plasticity index[2] | Specific gravity | Shrinkage: Limit | Linear | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Pct | | G/cc | Pct | Pct | Pct |
| Oakalla silty clay loam:[13] | | | | | | | | | | | | | | | | | |
| (S72TX-105-007) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 20 | A-7-6(30) | CH | 100 | 100 | 100 | 99 | 98 | 86 | 76 | 34 | 23 | 54 | 32 | 2.66 | 16.0 | 16.0 | 1.84 |
| A12------20 to 34 | A-7-6(24) | CH | 100 | 100 | 100 | 99 | 94 | 75 | 66 | 23 | 14 | 53 | 31 | 2.64 | 18.0 | 14.8 | 1.78 |
| C1-------34 to 74 | A-7-6(18) | CL | 100 | 100 | 99 | 97 | 83 | 64 | 69 | 37 | 30 | 49 | 32 | 2.69 | 15.0 | 14.8 | 1.86 |
| Sunev silty clay loam:[14] | | | | | | | | | | | | | | | | | |
| (S78TX-209-002) | | | | | | | | | | | | | | | | | |
| A11------ 6 to 15 | A-6 (14) | CL | 100 | 100 | 99 | 99 | 97 | 79 | 69 | 35 | 26 | 35 | 19 | 2.68 | 15.0 | 10.0 | 1.86 |
| B21ca----15 to 33 | A-6 (15) | CL | 100 | 100 | 100 | 99 | 99 | 84 | 76 | 41 | 30 | 36 | 19 | 2.70 | 17.0 | 9.4 | 1.83 |
| Tarpley clay:[15] | | | | | | | | | | | | | | | | | |
| (S72TX-105-008) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 6 | A-7-6(25) | CL | 96 | 95 | 94 | 93 | 91 | 87 | 83 | 53 | 45 | 46 | 26 | 2.67 | 14.0 | 14.5 | 1.88 |
| B2t------ 6 to 14 | A-7-6(32) | CH | 99 | 99 | 98 | 97 | 95 | 93 | 90 | 71 | 64 | 55 | 30 | 2.68 | 16.0 | 16.4 | 1.85 |
| Tinn clay:[16] | | | | | | | | | | | | | | | | | |
| (S72TX-105-006) | | | | | | | | | | | | | | | | | |
| A11------ 0 to 27 | A-7-6(45) | CH | 100 | 100 | 100 | 99 | 97 | 95 | 91 | 59 | 49 | 64 | 42 | 2.71 | 12.0 | 20.8 | 1.98 |
| A12------27 to 52 | A-7-6(43) | CH | 100 | 100 | 99 | 97 | 94 | 92 | 91 | 62 | 52 | 63 | 43 | 2.70 | 14.0 | 20.3 | 1.97 |
| C--------52 to 75 | A-7-6(40) | CH | 100 | 100 | 99 | 97 | 93 | 91 | 87 | 62 | 50 | 60 | 40 | 2.70 | 12.0 | 20.3 | 2.05 |
| Tinn clay:[17] | | | | | | | | | | | | | | | | | |
| (S72TX-105-009) | | | | | | | | | | | | | | | | | |
| A1------- 0 to 46 | A-7-6(52) | CH | 100 | 100 | 100 | 95 | 93 | 90 | 87 | 63 | 52 | 74 | 53 | 2.72 | 11.0 | 24.2 | 2.06 |
| B2--------46 to 88 | A-7-6(47) | CH | 97 | 97 | 96 | 99 | 94 | 90 | 87 | 58 | 48 | 68 | 46 | 2.71 | 10.0 | 23.0 | 2.05 |
| C--------88 to 96 | A-7-6(42) | CH | 100 | 100 | 100 | 91 | 84 | 80 | 79 | 55 | 44 | 72 | 49 | 2.72 | 11.0 | 23.8 | 2.06 |

[1]For soil materials larger than 3/8 inch, square mesh wire sieves were used that are slightly larger than equivalent round sieves. This difference does not seriously affect the data.

[2]Liquid limit and plasticity index values were determined by the AASHTO-89 and AASHTO-90 methods except that soil was added to water.

[3]Altoga silty clay: 1.8 miles east of junction of Farm Road 621 and Texas 123 along Farm Road 621; 50 feet south.

[4]Boerne fine sandy loam: From I-35 and Texas 80 in San Marcos, 2.8 miles northeast on I-35 and 600 feet west.

[5]Bolar clay loam: 1,800 feet southwest of Owen Goodnight Junior High School and 100 feet east of I-35; in San Marcos.

[6]Branyon clay: 1,800 feet southwest of Owen Goodnight Junior High School and 100 feet east of I-35; in San Marcos.

[7]Ferris clay: From intersection of I-35 and Farm Road 725 in New Braunfels, 6 miles north on I-35, 0.7 mile southeast on Watson Lane, and 700 feet south.

[8]Krum clay: 300 feet west of Travis Elementary School on Lime Kiln Road and 50 feet south; in San Marcos.

[9]Lewisville silty clay: From intersection of I-35 and Center Street in Kyle, 1.2 miles west on Center Street, 2.4 miles south on county road, and 120 feet northwest.

[10]Lewisville silty clay: From intersection of Texas 21 and Texas 80 in San Marcos, 1.9 miles northeast on Texas 21, 0.7 mile northwest on county road, and 100 feet northeast.

[11]Medlin stony clay: From intersection of I-35 and Farm Road 306 in New Braunfels, 2.5 miles northwest on Farm Road 306, 1.1 miles west on county road, and 186 feet south.

[12]Medlin clay: From Travis Elementary School in San Marcos, 1.7 miles northwest on Lime Kiln Road, 0.4 mile north on private road, and 300 feet west, in a pasture.

[13]Oakalla silty clay loam: 500 feet south of Cheatham Street bridge on San Marcos River in Rio Vista Park; in San Marcos.

[14]Sunev silty clay loam: Fine-silty taxadjunct to Sunev series. From intersection of Texas 80 and Texas 21 in San Marcos, 1.8 miles southeast on Texas 80, 0.1 mile south and 0.5 mile west on county road, and 85 feet north.

[15]Tarpley clay: From intersection of Bishop Street and Franklin Drive in San Marcos, 1 mile southwest on private road.

[16]Tinn clay: 500 feet west of San Marcos River Bridge on I-35; in San Marcos.

[17]Tinn clay: In softball field parking lot, across Hopkins Street from Catholic Church; in San Marcos.

TABLE 17.--CLASSIFICATION OF THE SOILS

| Soil name | Family or higher taxonomic class |
|---|---|
| Altoga | Fine-silty, carbonatic, thermic Typic Ustochrepts |
| Anhalt | Very-fine, montmorillonitic, thermic Udic Chromusterts |
| Austin | Fine-silty, carbonatic, thermic Entic Haplustolls |
| Boerne | Coarse-loamy, carbonatic, thermic Fluventic Ustochrepts |
| Bolar | Fine-loamy, carbonatic, thermic Typic Calciustolls |
| Brackett | Loamy, carbonatic, thermic, shallow Typic Ustochrepts |
| Branyon | Fine, montmorillonitic, thermic Udic Pellusterts |
| Castephen | Loamy, carbonatic, thermic, shallow Entic Haplustolls |
| Comfort | Clayey-skeletal, mixed, thermic Lithic Argiustolls |
| Denton | Fine, montmorillonitic, thermic Vertic Calciustolls |
| Doss | Loamy, carbonatic, thermic, shallow Typic Calciustolls |
| Eckrant | Clayey-skeletal, montmorillonitic, thermic Lithic Haplustolls |
| Ferris | Fine, montmorillonitic, thermic Udorthentic Chromusterts |
| Gruene | Clayey, mixed, thermic, shallow Petrocalcic Paleustolls |
| Heiden | Fine, montmorillonitic, thermic Udic Chromusterts |
| Houston Black | Fine, montmorillonitic, thermic Udic Pellusterts |
| Krum | Fine, montmorillonitic, thermic Vertic Haplustolls |
| Lewisville | Fine-silty, mixed, thermic Typic Calciustolls |
| Medlin | Fine, montmorillonitic, thermic Udorthentic Chromusterts |
| Oakalla | Fine-loamy, carbonatic, thermic Cumulic Haplustolls |
| Orif | Sandy-skeletal, carbonatic, thermic Typic Ustifluvents |
| Pedernales | Fine, mixed, thermic Udic Paleustalfs |
| Purves | Clayey, montmorillonitic, thermic Lithic Calciustolls |
| Real | Loamy-skeletal, carbonatic, thermic, shallow Typic Calciustolls |
| Rumple | Clayey-skeletal, mixed, thermic Udic Argiustolls |
| Seawillow | Fine-loamy, carbonatic, thermic Typic Ustochrepts |
| *Sunev | Fine-loamy, carbonatic, thermic Typic Calciustolls |
| Tarpley | Clayey, montmorillonitic, thermic Lithic Vertic Argiustolls |
| Tinn | Fine, montmorillonitic (calcareous), thermic Vertic Haplaquolls |

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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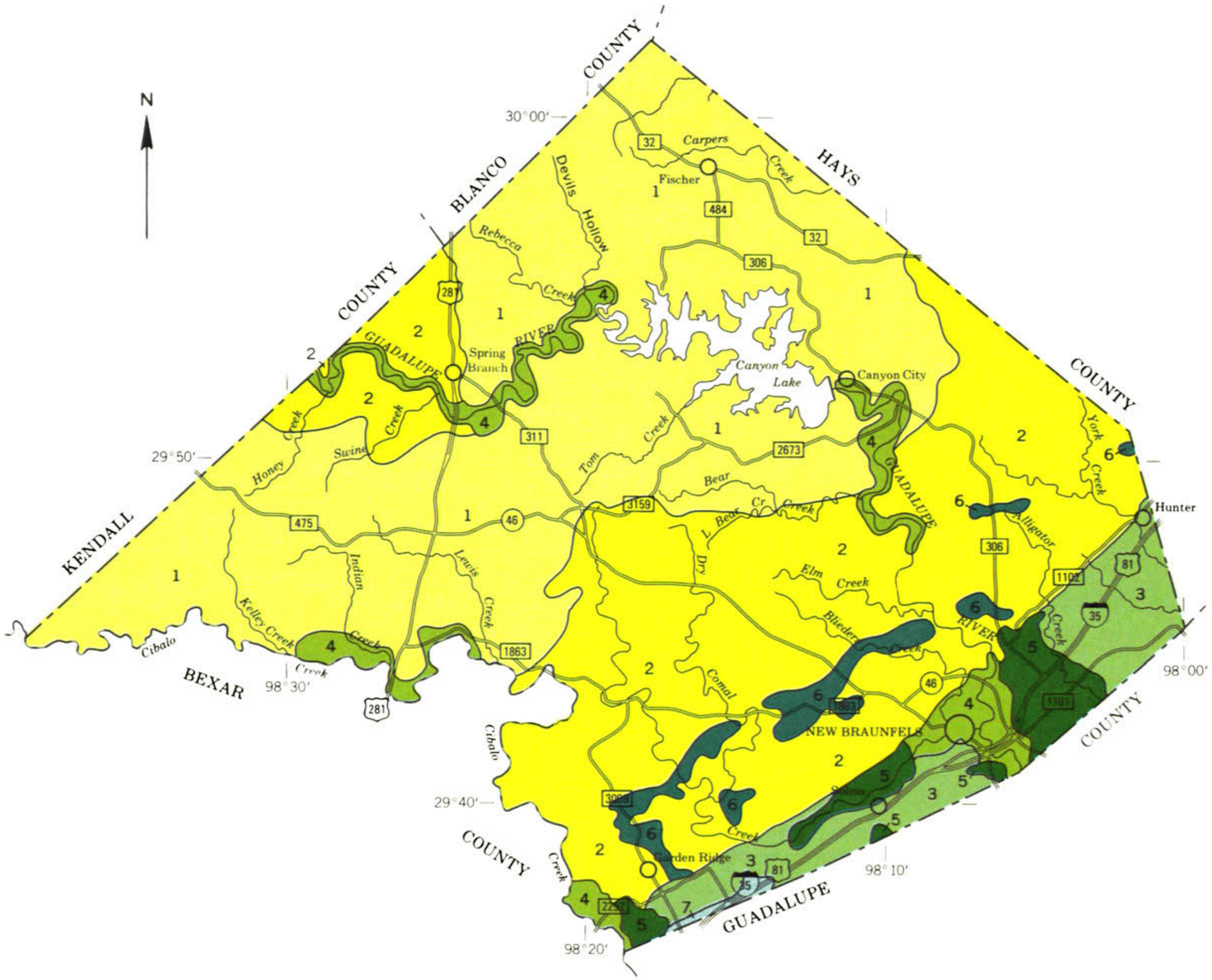



# LEGEND

| | |
|---|---|
| 1 | BRACKETT-COMFORT-REAL: Shallow, undulating to steep soils over limestone or strongly cemented chalk; on uplands of Edwards Plateau |
| 2 | COMFORT-RUMPLE-ECKRANT: Very shallow to moderately deep, undulating to steep and hilly soils over indurated limestone; on uplands of Edwards Plateau |
| 3 | HEIDEN-HOUSTON BLACK: Deep, gently sloping to sloping soils over clay and shale; on uplands of Blackland Prairie |
| 4 | LEWISVILLE-GRUENE-KRUM: Deep, shallow, and very shallow, nearly level to gently sloping soils over loamy, clayey, and gravelly sediments; on stream terraces and valley fills of Blackland Prairie and Edwards Plateau |
| 5 | BRANYON-KRUM: Deep, nearly level to gently sloping soils over clayey sediments; on ancient stream terraces and valley fills of Blackland Prairie |
| 6 | KRUM-MEDLIN-ECKRANT: Deep, very shallow, and shallow, undulating to steep and hilly soils over clay, shaley clay, and limestone; on stream terraces, valley fills, and uplands of Edwards Plateau |
| 7 | AUSTIN-CASTEPHEN-HOUSTON BLACK: Shallow to deep, gently sloping to sloping soils over chalk or marly clay; on uplands of Blackland Prairie |

Compiled 1982

*Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.*

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

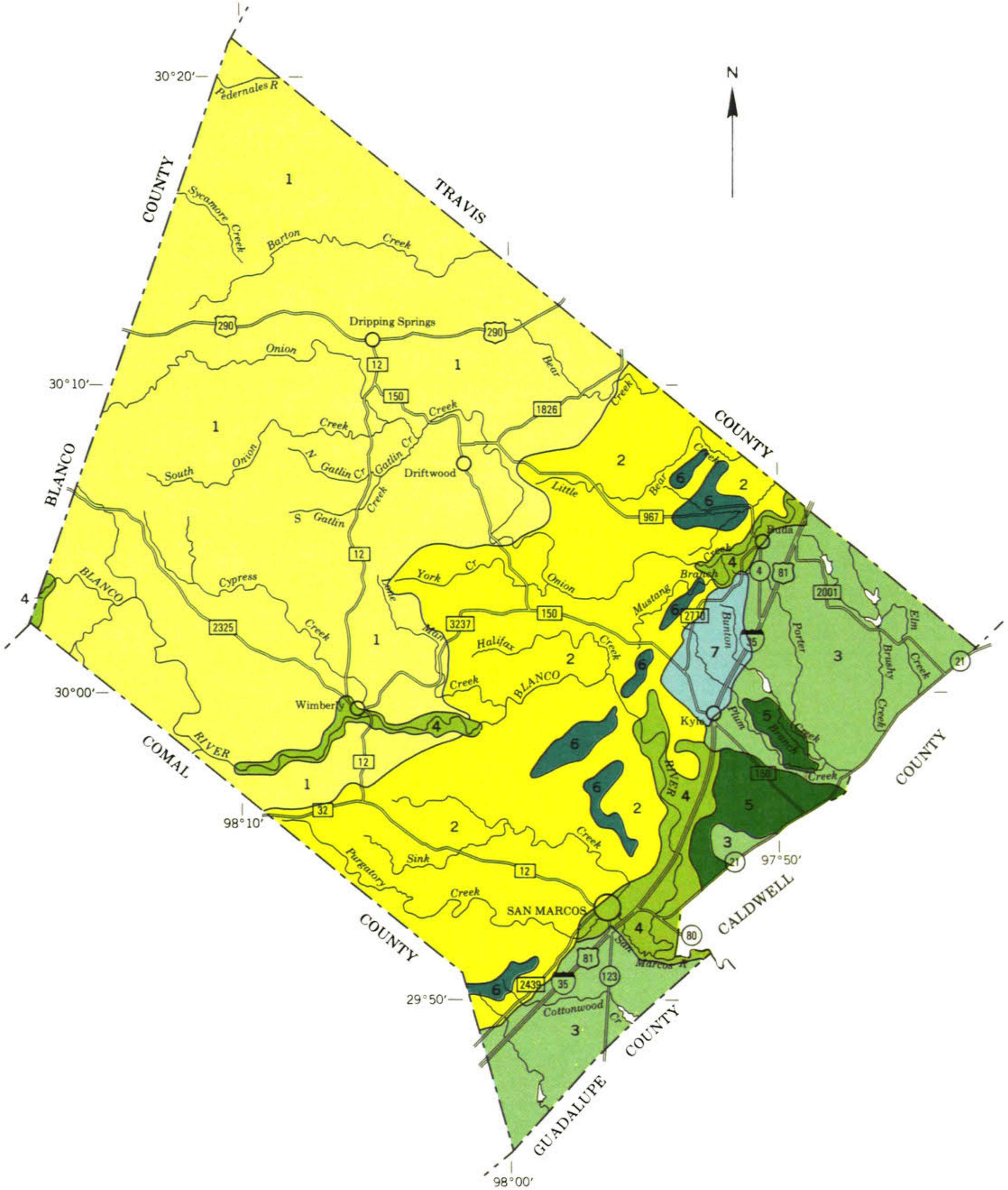
# GENERAL SOIL MAP

## COMAL COUNTY, TEXAS

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km




# LEGEND

| | |
|---|---|
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Compiled 1982

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

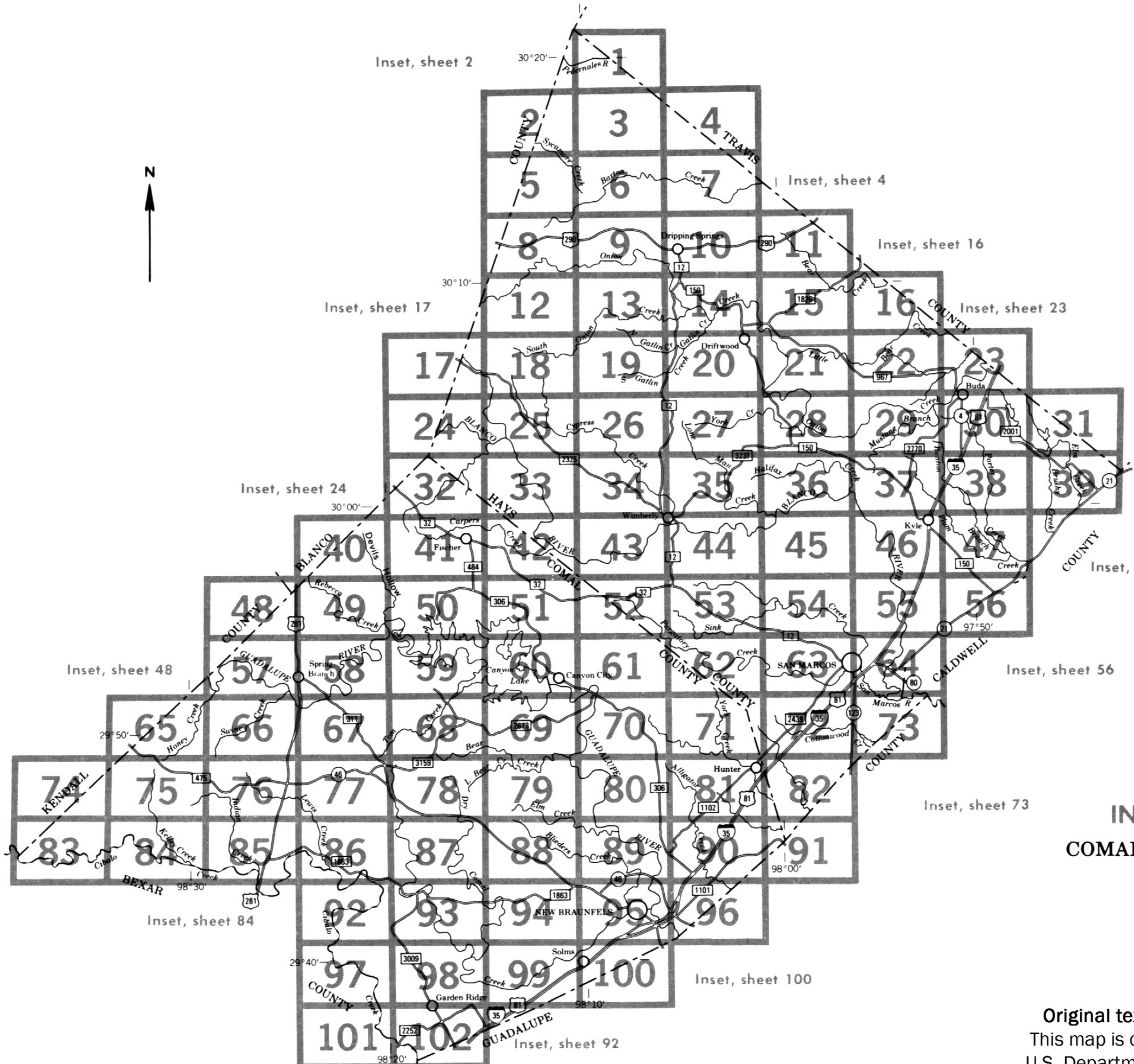
# GENERAL SOIL MAP

## HAYS COUNTY, TEXAS

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km




## INDEX TO MAP SHEETS

### COMAL AND HAYS COUNTIES, TEXAS

Scale 1:380,160

1 0 1 2 3 4 5 6 Miles

1 0 5 10 Km

**Original text from each individual map sheet read:**
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

# SOIL LEGEND

The first letter, always a capital, is the initial letter of the soil name. The second letter is a capital if the mapping unit is broadly defined 1/; otherwise, it is a small letter. The third letter, if used, is always a capital and shows the slope. Symbols without slope letters are those of nearly level soils or miscellaneous areas. A final number, such as 3 in the symbol, shows that the soil is eroded.

| SYMBOL | NAME |
|---|---|
| AgC3 | Altoga silty clay, 2 to 5 percent slopes, eroded |
| AgD3 | Altoga silty clay, 5 to 8 percent slopes, eroded |
| AnA | Anhalt clay, 0 to 1 percent slopes |
| AnB | Anhalt clay, 1 to 3 percent slopes |
| AuB | Austin-Castephen complex, 1 to 3 percent slopes |
| AuC3 | Austin-Castephen complex, 2 to 5 percent slopes, eroded |
| BoB | Boerne fine sandy loam, 1 to 3 percent slopes |
| BrB | Bolar clay loam, 1 to 3 percent slopes |
| BtD | Brackett-Rock outcrop-Comfort complex, undulating |
| BtG | Brackett-Rock outcrop-Real complex, steep |
| ByA | Branyon clay, 0 to 1 percent slopes |
| ByB | Branyon clay, 1 to 3 percent slopes |
| CaC3 | Castephen clay loam, 3 to 5 percent slopes, eroded |
| CrD | Comfort-Rock outcrop complex, undulating |
| DeB | Denton silty clay, 1 to 3 percent slopes |
| DeC3 | Denton silty clay, 1 to 5 percent slopes, eroded |
| DoC | Doss silty clay, 1 to 5 percent slopes |
| ErG | Eckrant-Rock outcrop complex, steep |
| FeF4 | Ferris clay, 5 to 20 percent slopes, severely eroded |
| GrC | Gruene clay, 1 to 5 percent slopes |
| HeB | Heiden clay, 1 to 3 percent slopes |
| HeC3 | Heiden clay, 3 to 5 percent slopes, eroded |
| HeD3 | Heiden clay, 5 to 8 percent slopes, eroded |
| HgD | Heiden gravelly clay, 3 to 8 percent slopes |
| HoB | Houston Black clay, 1 to 3 percent slopes |
| HvB | Houston Black gravelly clay, 1 to 3 percent slopes |
| HvD | Houston Black gravelly clay, 3 to 8 percent slopes |
| KrA | Krum clay, 0 to 1 percent slopes |
| KrB | Krum clay, 1 to 3 percent slopes |
| KrC | Krum clay, 3 to 5 percent slopes |
| LeA | Lewisville silty clay, 0 to 1 percent slopes |
| LeB | Lewisville silty clay, 1 to 3 percent slopes |
| MEC | Medlin-Eckrant association, undulating 1/ |
| MED | Medlin-Eckrant association, hilly 1/ |
| Oa | Oakalla silty clay loam, rarely flooded |
| Ok | Oakalla soils, frequently flooded |
| Or | Orif soils, frequently flooded |
| PdB | Pedernales fine sandy loam, 1 to 5 percent slopes |
| Pt | Pits |
| PuC | Purves clay, 1 to 5 percent slopes |
| RaD | Real gravelly loam, 1 to 8 percent slopes |
| RcD | Real-Comfort-Doss complex, undulating |
| RUD | Rumple-Comfort association, undulating 1/ |
| SeB | Seawillow clay loam, 1 to 3 percent slopes |
| SeD | Seawillow clay loam, 3 to 8 percent slopes |
| SuA | Sunev silty clay loam, 0 to 1 percent slopes |
| SuB | Sunev clay loam, 1 to 3 percent slopes |
| TaB | Tarpley clay, 1 to 3 percent slopes |
| Tn | Tinn clay, frequently flooded |

1/ The composition of these units is more variable than that of others in the survey area, but has been controlled well enough to be interpreted for the expected use of the soils.

# CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

## CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label) — Hedley Airstrip

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

## WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

## SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CnB, WaC2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

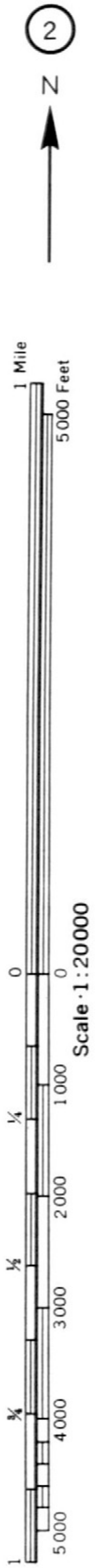
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 1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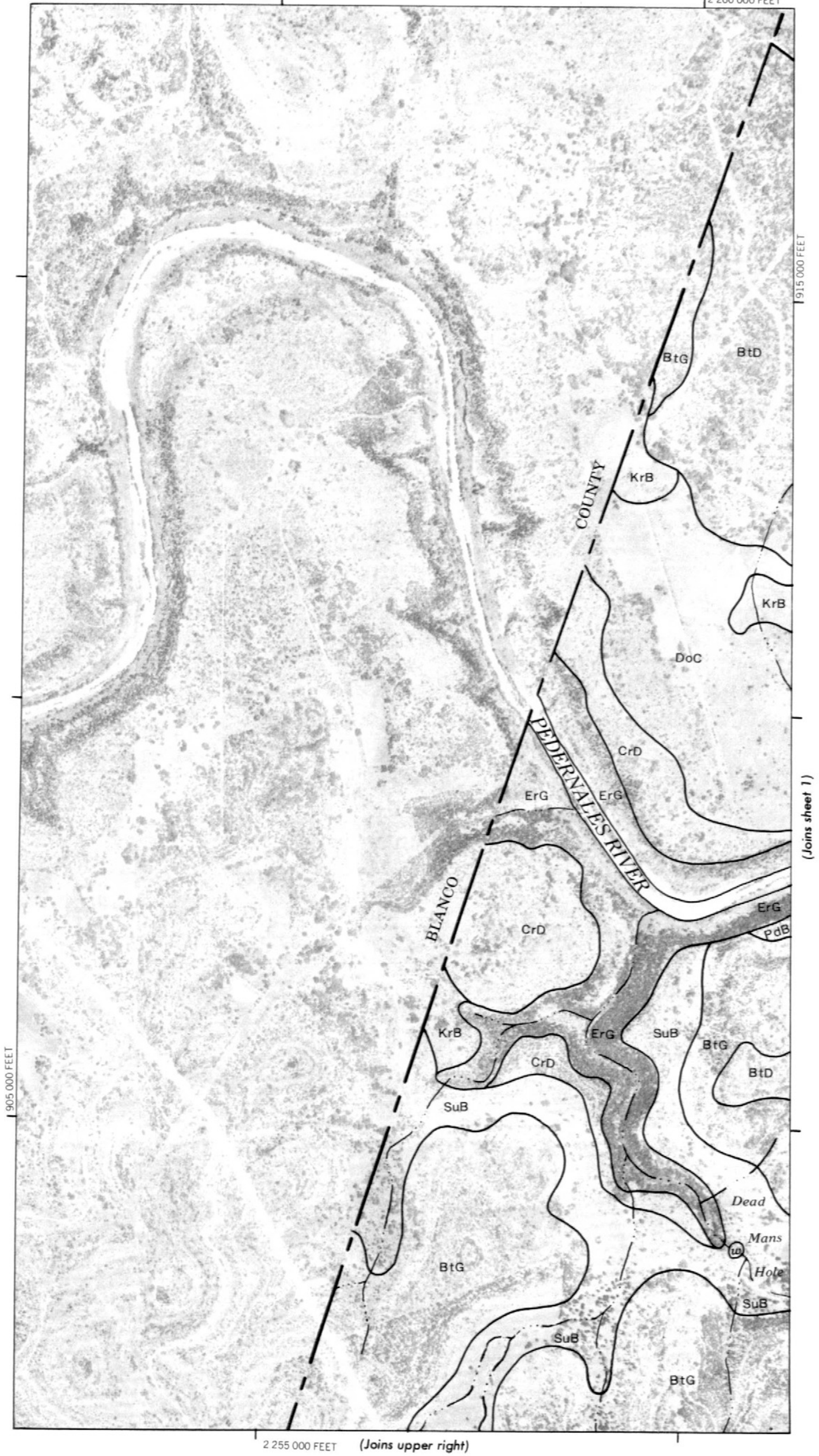
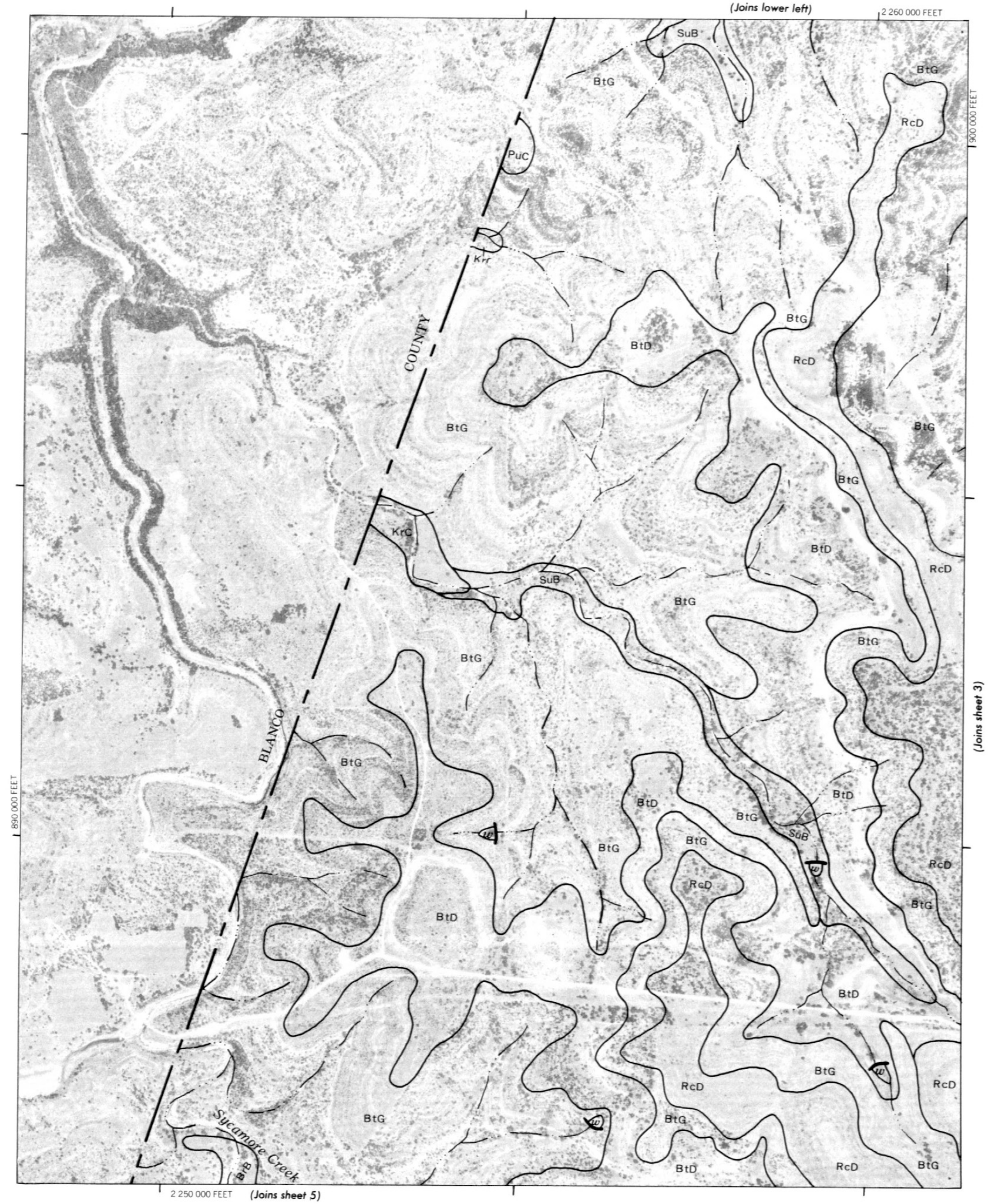
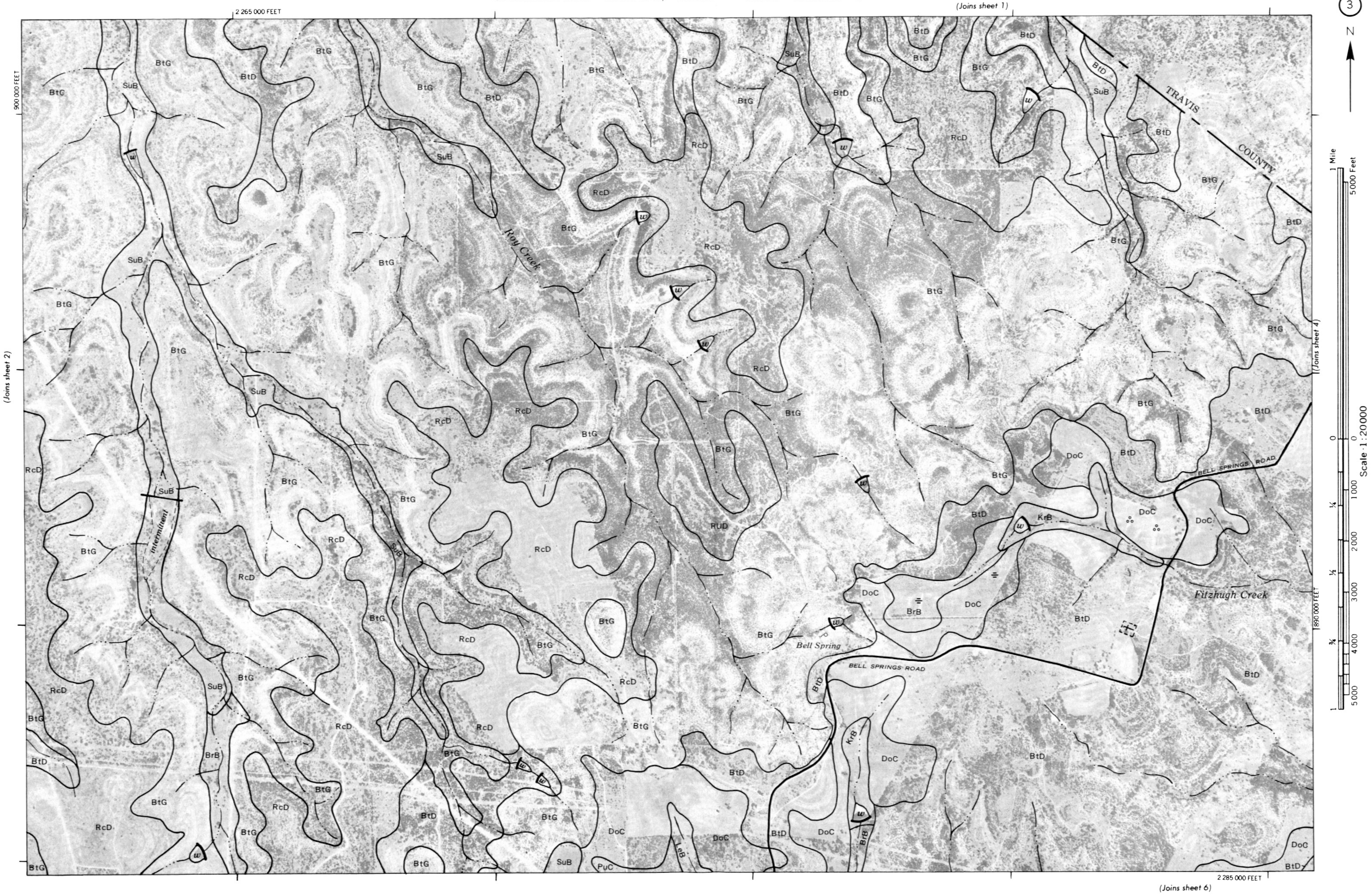
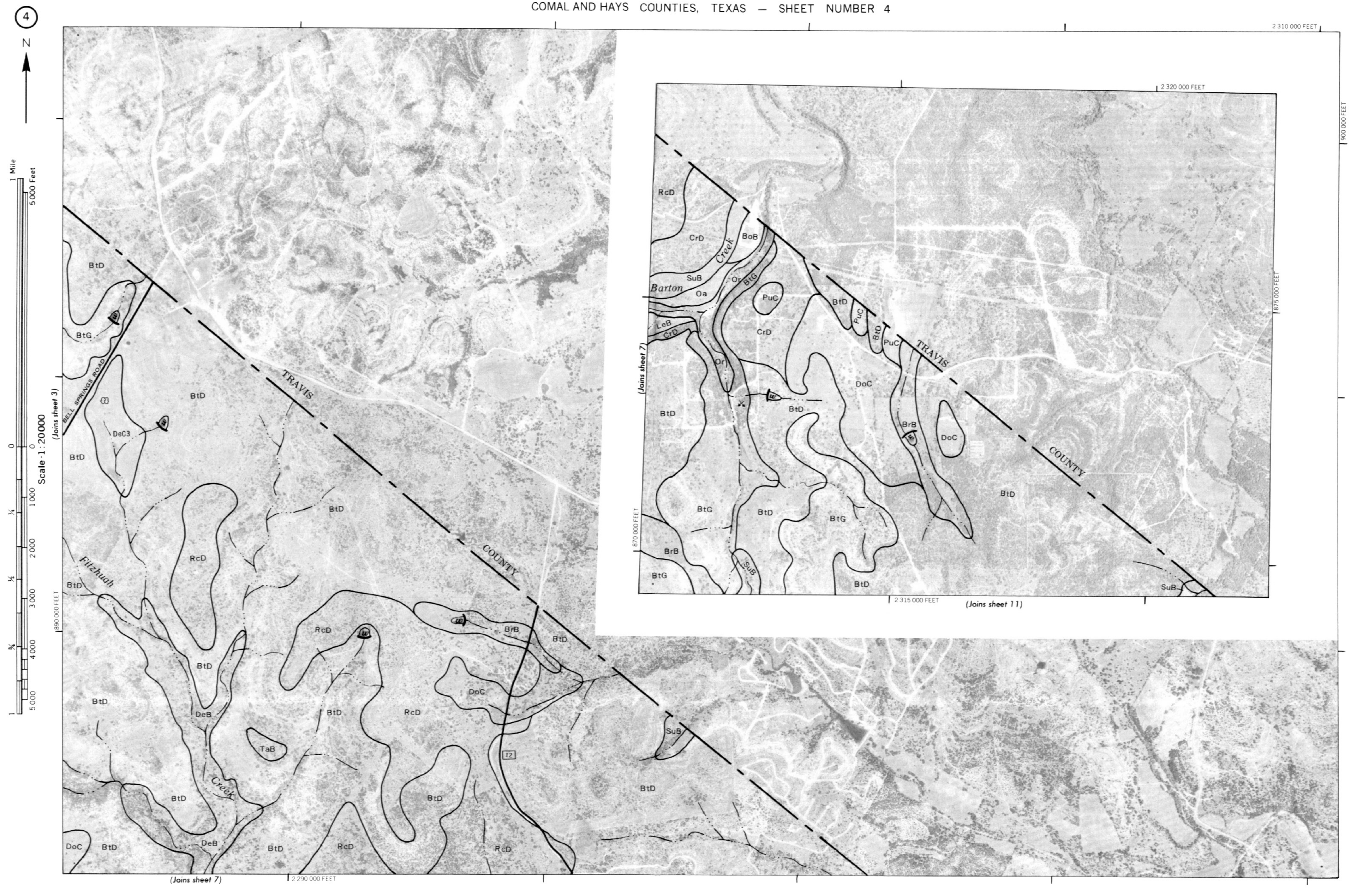
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1

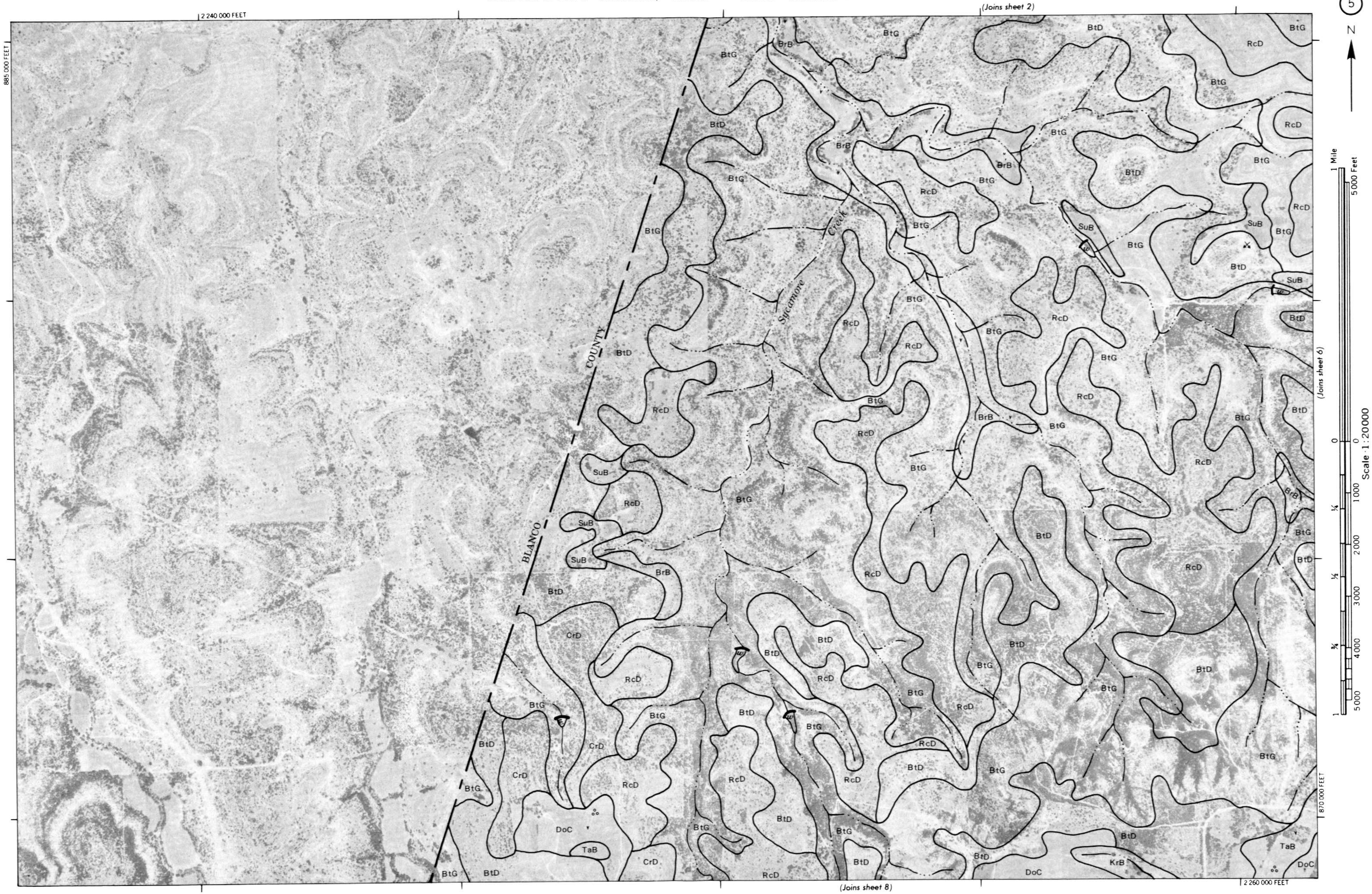

2 260 000 FEET
915 000 FEET
905 000 FEET
2 255 000 FEET
(Joins upper right)
(Joins sheet 1)
BLANCO
COUNTY
PEDERNALES RIVER
Dead
Mans
Hole
BtG
BtD
KrB
KrB
DoC
CrD
ErG
ErG
ErG
CrD
PdB
KrB
ErG
SuB
BtG
BtD
CrD
SuB
BtG
SuB
SuB
BtG

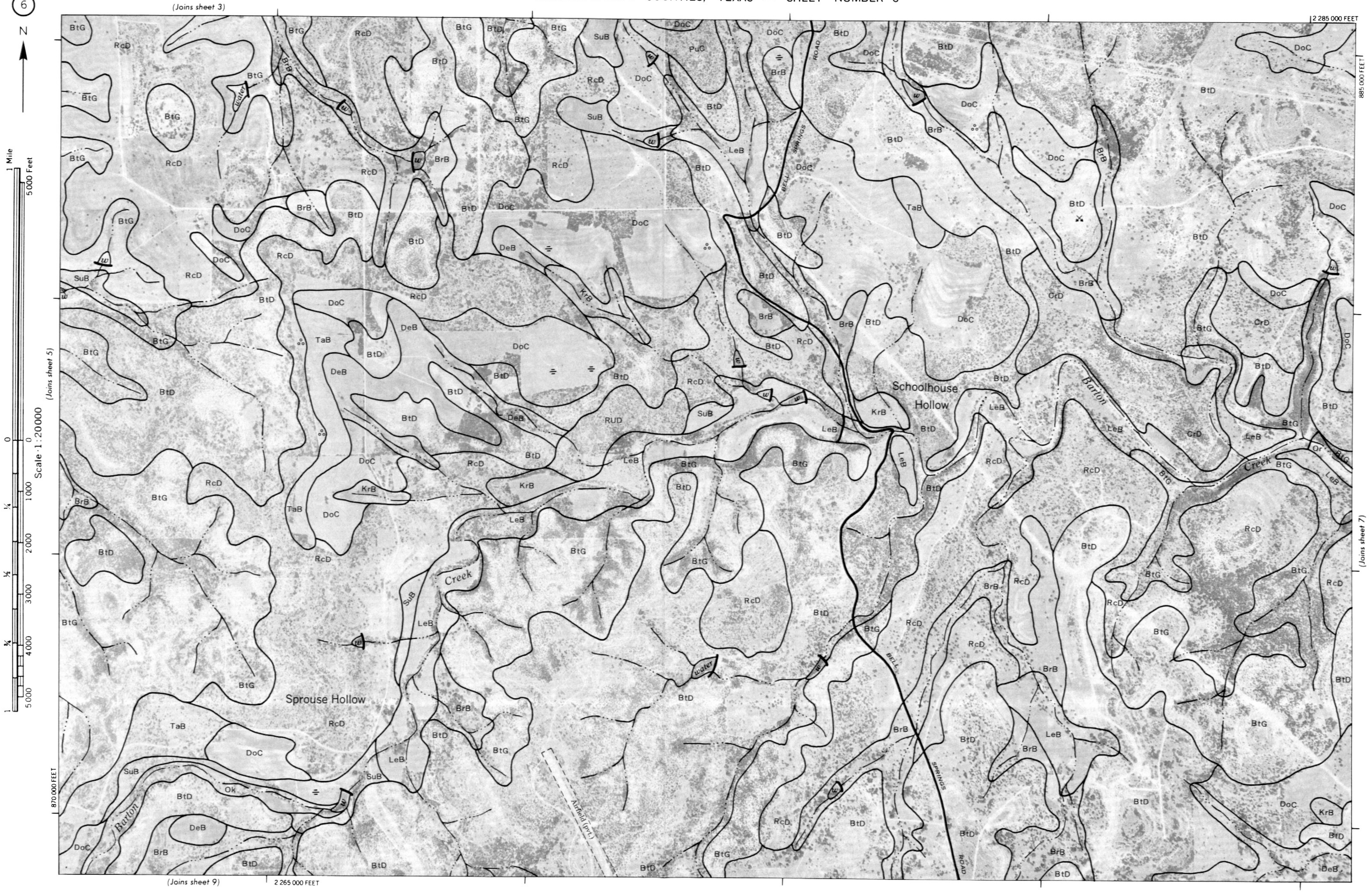

(Joins lower left)
2 260 000 FEET
900 000 FEET
890 000 FEET
2 250 000 FEET
(Joins sheet 5)
(Joins sheet 3)
BLANCO
COUNTY
Sycamore Creek
SuB
BtG
BtG
RcD
PuC
Krf
BtG
BtD
RcD
BtG
BtG
BtG
KrC
SuB
BtD
BtG
RcD
BtG
BtG
BtG
BtD
BtG
SuB
BtD
BtG
BtG
RcD
RcD
BtG
BtD
BtD
BtG
RcD
RcD
BtG
BtG
BtG
BrB
BtD
RcD
BtG

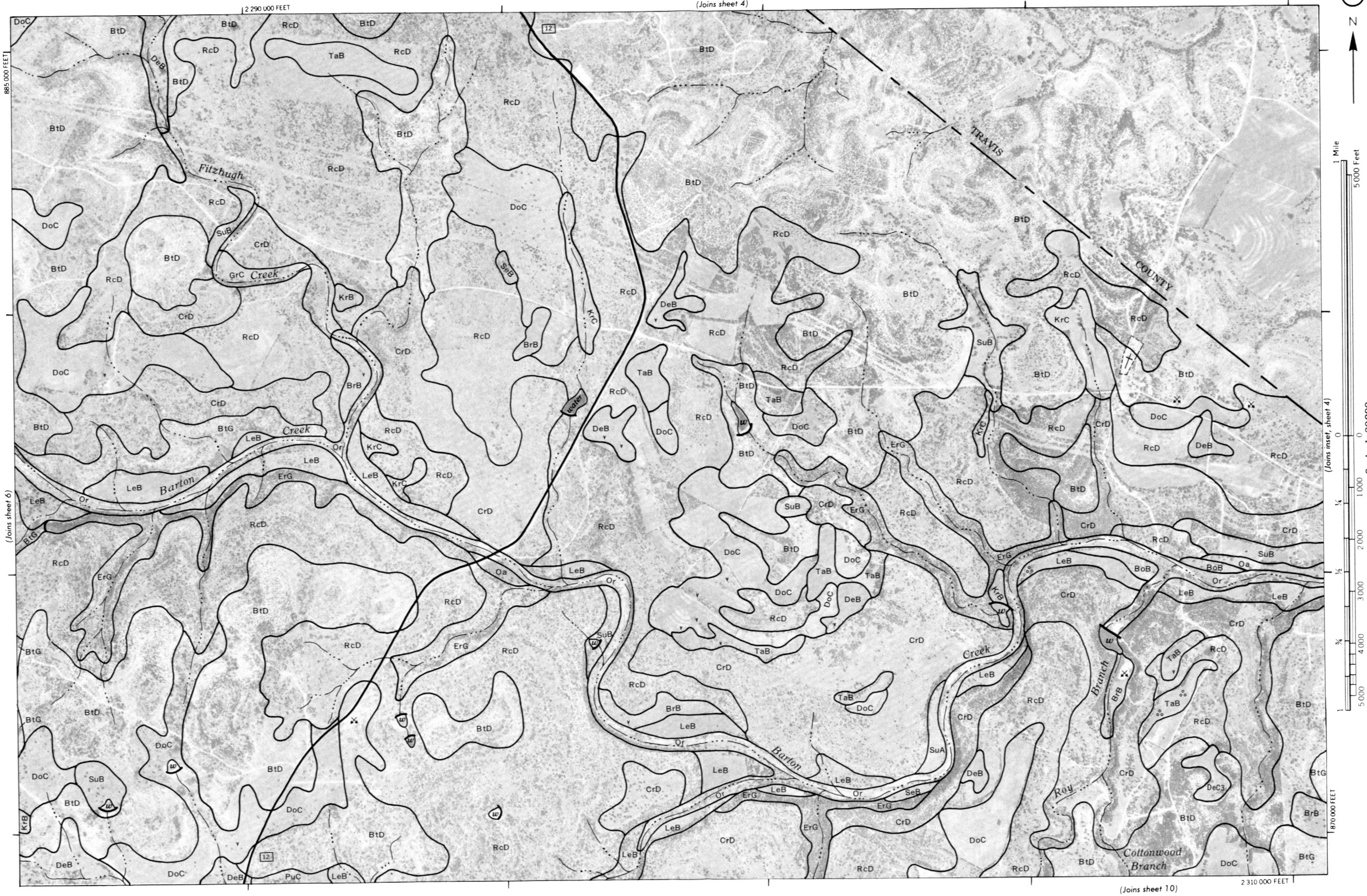
COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 3




4
N
1 Mile
5 000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
(Joins sheet 3)
(Joins sheet 7)
(Joins sheet 11)
2 310 000 FEET
2 320 000 FEET
2 315 000 FEET
2 290 000 FEET
900 000 FEET
875 000 FEET
870 000 FEET
890 000 FEET
TRAVIS COUNTY
BELL SPRINGS ROAD
Fitzhugh Creek
Barton Creek
12
BtD
BtG
DeC3
RcD
DeB
TaB
DoC
BrB
SuB
CrD
BoB
SuB
Oa
Or
LeB
PuC
BrB

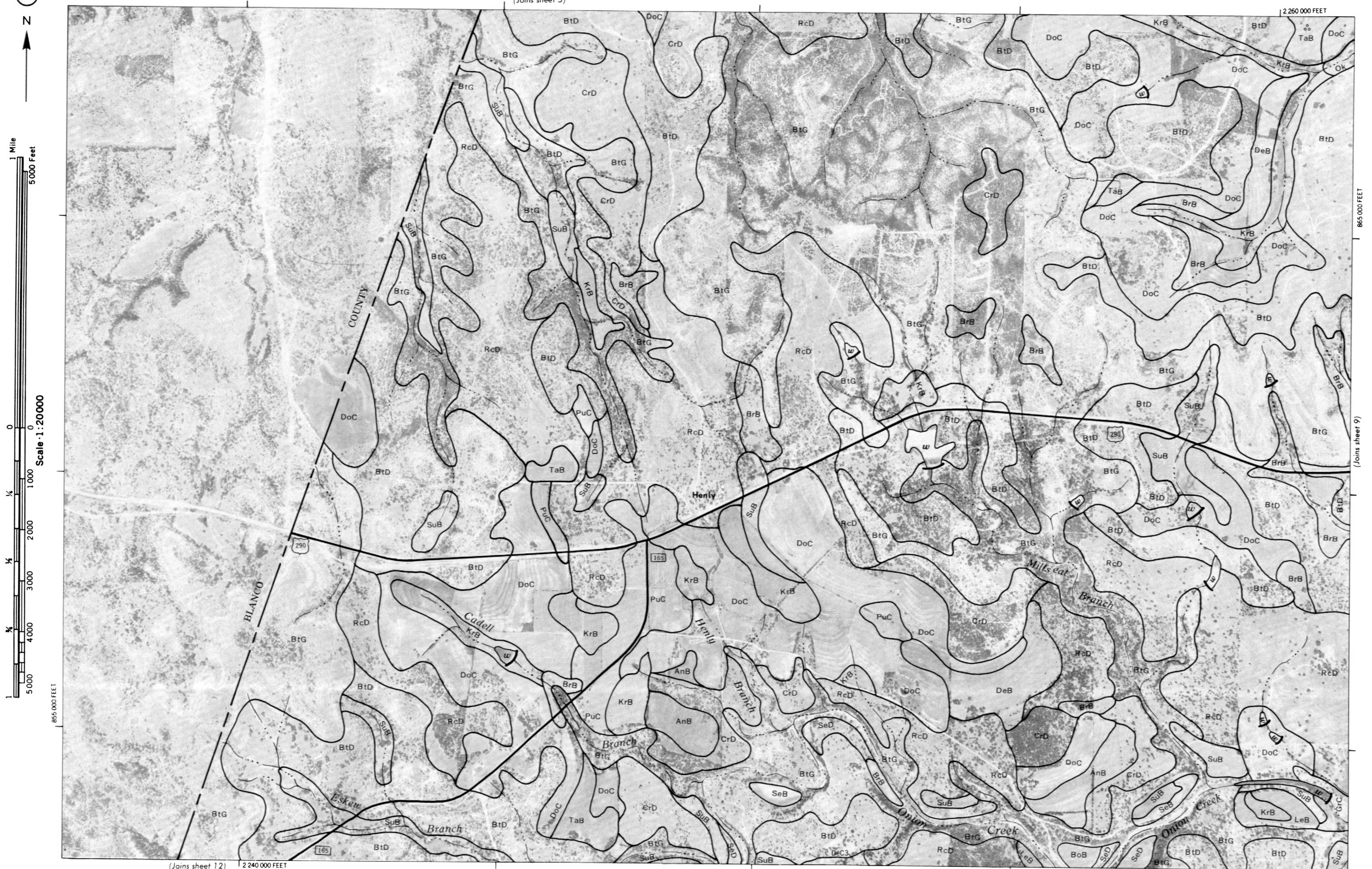

5
N
2 240 000 FEET
885 000 FEET
(Joins sheet 2)
(Joins sheet 6)
(Joins sheet 8)
870 000 FEET
2 260 000 FEET
BLANCO COUNTY
Sycamore Creek
BtG
BtD
BrB
RcD
SuB
CrD
DoC
TaB
KrB
1 Mile
5 000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000


(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 9)
N
1 Mile
5000 Feet
Scale 1:20000
2 285 000 FEET
885 000 FEET
870 000 FEET
2 265 000 FEET
Schoolhouse Hollow
Sprouse Hollow
Barton Creek
BELL SPRINGS ROAD
Airfield (pvt.)
water

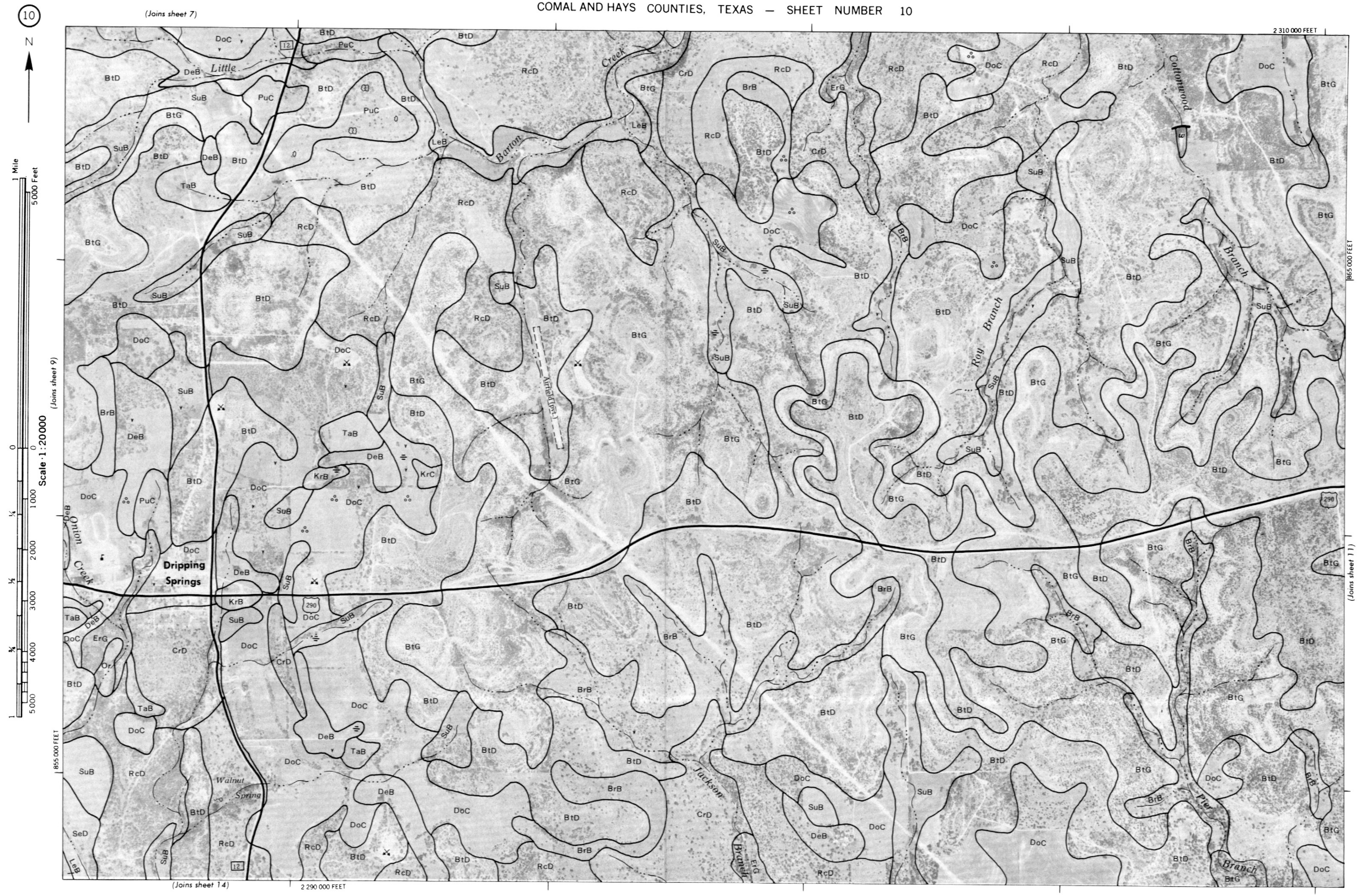


7
N
2 290 000 FEET
(Joins sheet 4)
885 000 FEET
(Joins sheet 6)
(Joins inset, sheet 4)
870 000 FEET
2 310 000 FEET
(Joins sheet 10)
TRAVIS
COUNTY
Fitzhugh
Creek
Barton
Creek
Barton
Creek
Roy
Branch
Branch
Cottonwood
Branch
water
12
12
1 Mile
5000 Feet
Scale 1:20000

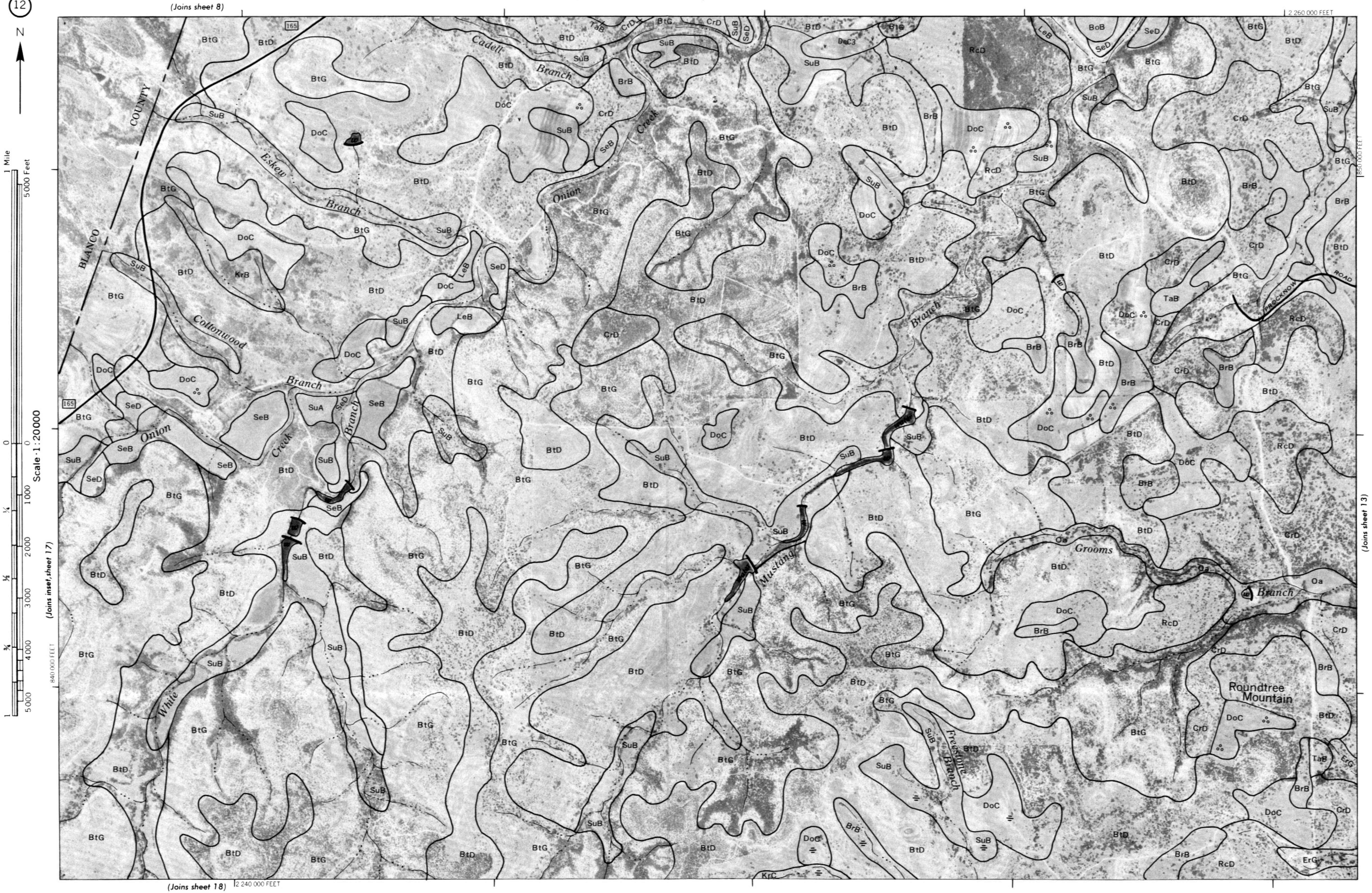
COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 8



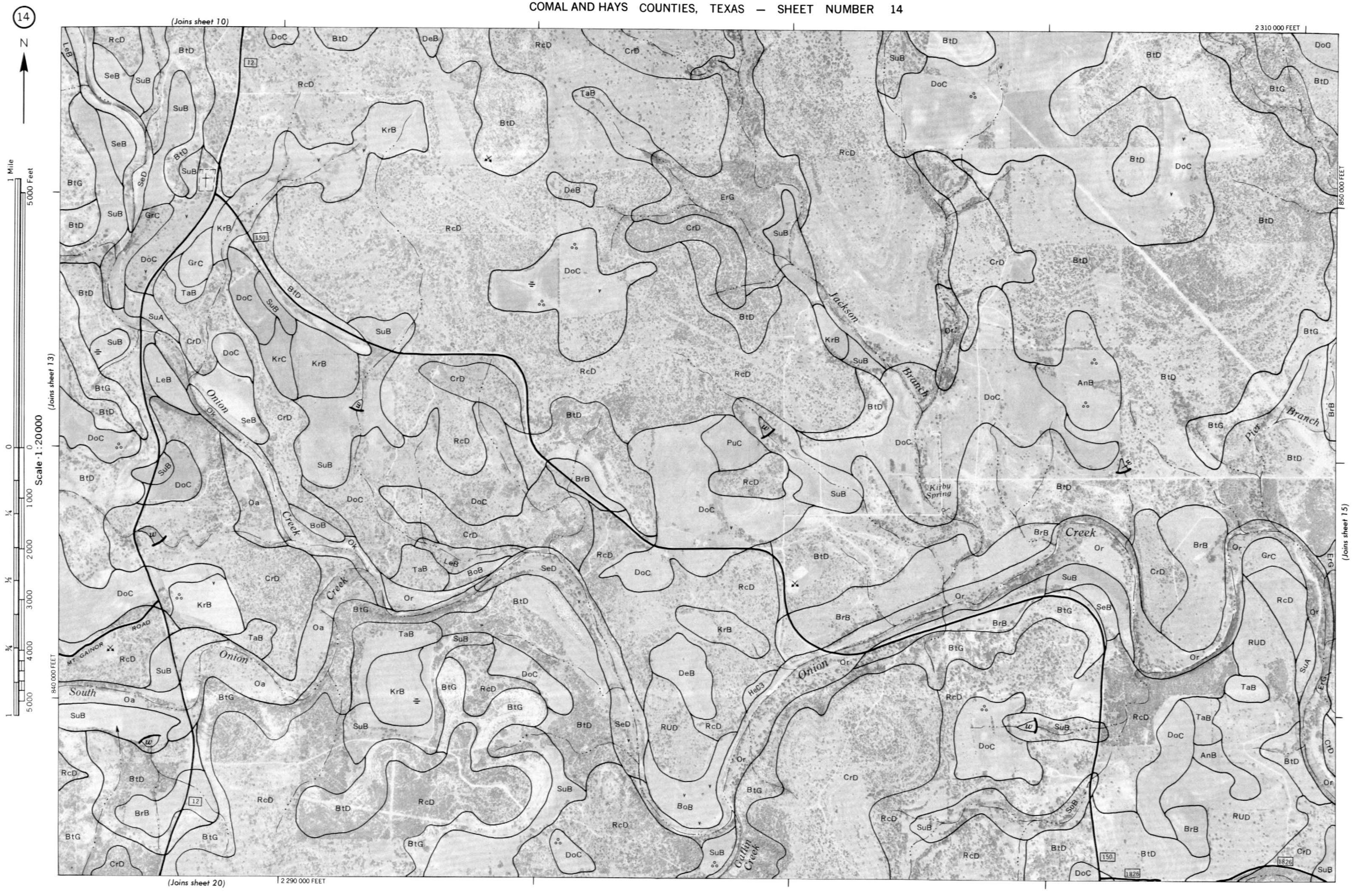

(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 13)
2 265 000 FEET
2 285 000 FEET
865 000 FEET
855 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
Little Barton Creek
Onion Creek
BELL SPRINGS ROAD
Airfield
290
water


10
N
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 14)
2 310 000 FEET
2 290 000 FEET
865 000 FEET
855 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Little
Barton
Creek
Cottonwood
Branch
Roy
Branch
Onion
Creek
Dripping
Springs
Airfield (pvt.)
Walnut
Spring
Jackson
Branch
Pier
Branch
12
290
BtD
BtG
DoC
DeB
SuB
PuC
RcD
CrD
LeB
TaB
BrB
ErG
KrB
KrC
Or
SeD

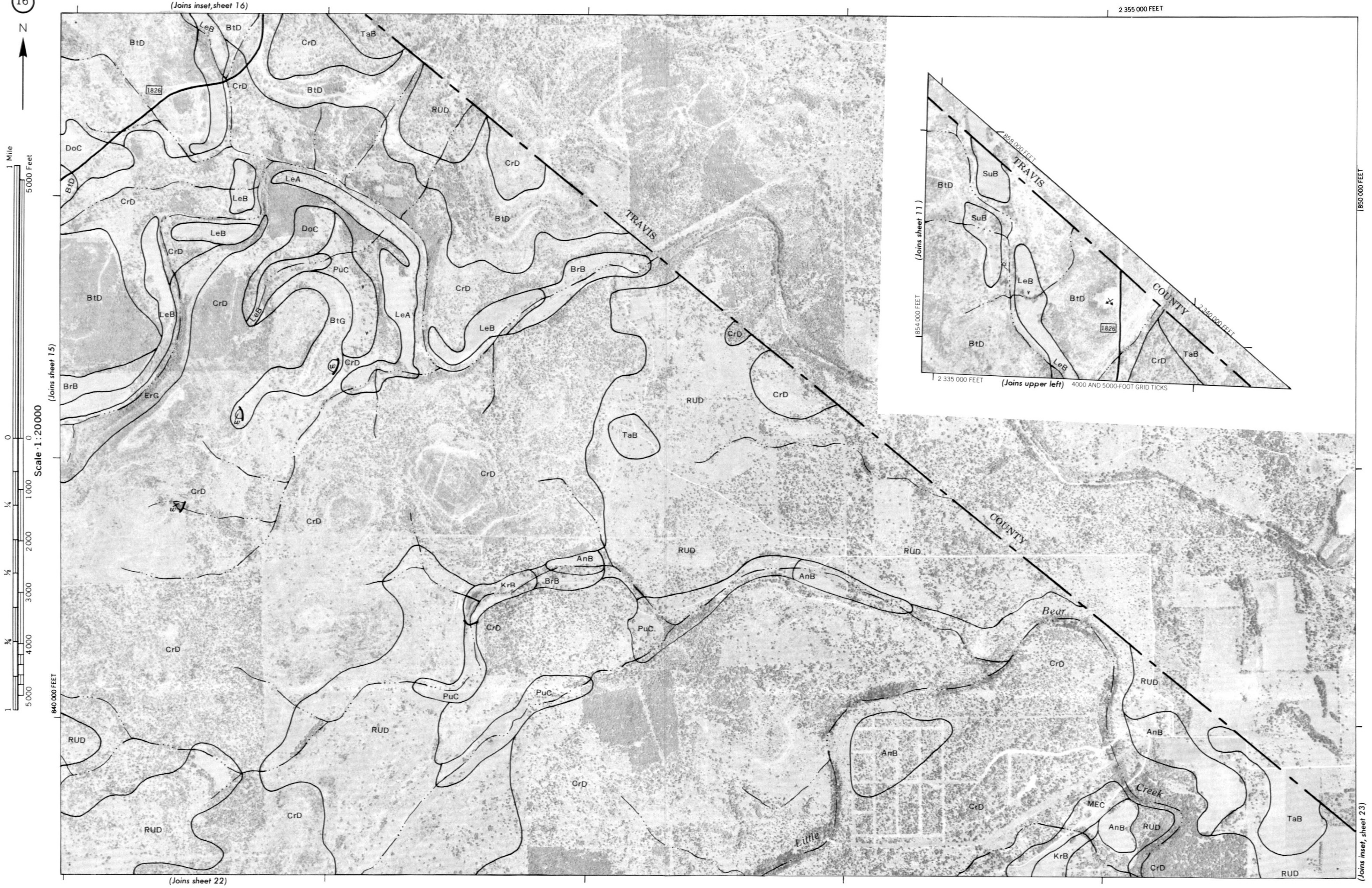

11
N
(Joins inset, sheet 4)
2 315 000 FEET
865 000 FEET
(Joins sheet 10)
(Joins sheet 15)
2 335 000 FEET
(Joins inset, sheet 16)
TRAVIS
COUNTY
290
Long
Branch
Bear
Creek
Signal Hill
water
1 Mile
5000 Feet
Scale 1:20000


12
N
(Joins sheet 8)
(Joins sheet 18)
(Joins inset, sheet 17)
(Joins sheet 13)
2 260 000 FEET
2 240 000 FEET
850 000 FEET
840 000 FEET
1 Mile
5000 Feet
Scale 1:20000
BLANCO
COUNTY
Eskew
Branch
Cottonwood
Branch
Onion
Creek
White
Cadell
Branch
Mustang
Grooms
Branch
Freestone
Branch
Roundtree
Mountain
PROCKNOW
ROAD
165
BtD
BtG
SuB
DoC
CrD
SeB
SeD
LeB
KrB
SuA
BrB
RcD
TaB
BoB
DeC3
Oa
ErG
KrC

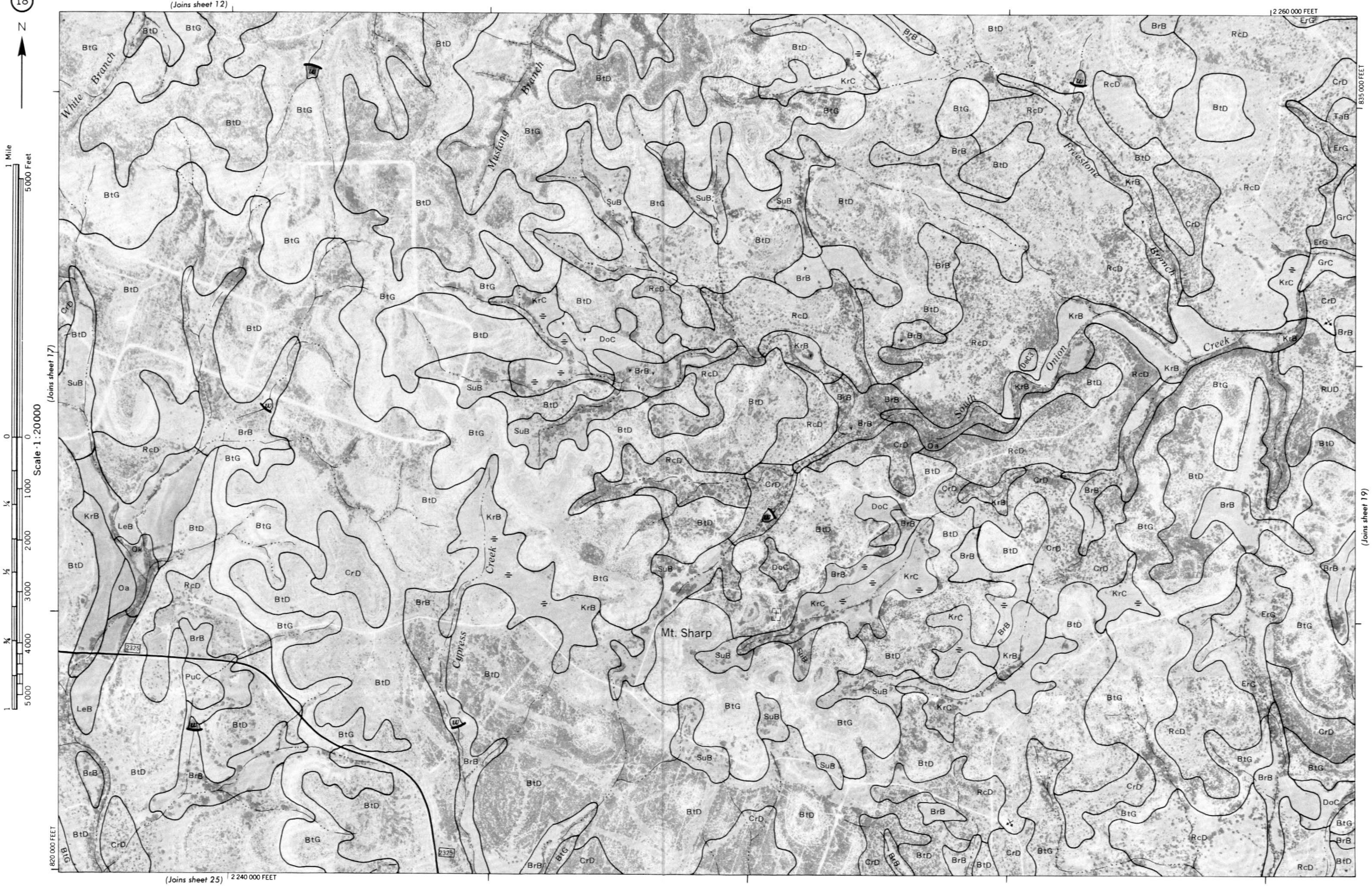

13
N
2 265 000 FEET
850 000 FEET
840 000 FEET
2 285 000 FEET
(Joins sheet 9)
(Joins sheet 14)
(Joins sheet 19)
(Joins sheet 12)
Gainor
Mountain
PROCKNOW
ROAD
MT. GAINOR
ROAD
COOLEY
Grooms
Branch
Onion
Creek
South
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
0
5000


14
N
(Joins sheet 10)
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
2 310 000 FEET
850 000 FEET
840 000 FEET
2 290 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Onion Creek
Jackson Branch
Pier Branch
Kirby Spring
Gallin Creek
South
MT. GAINOR ROAD
12
150
1826

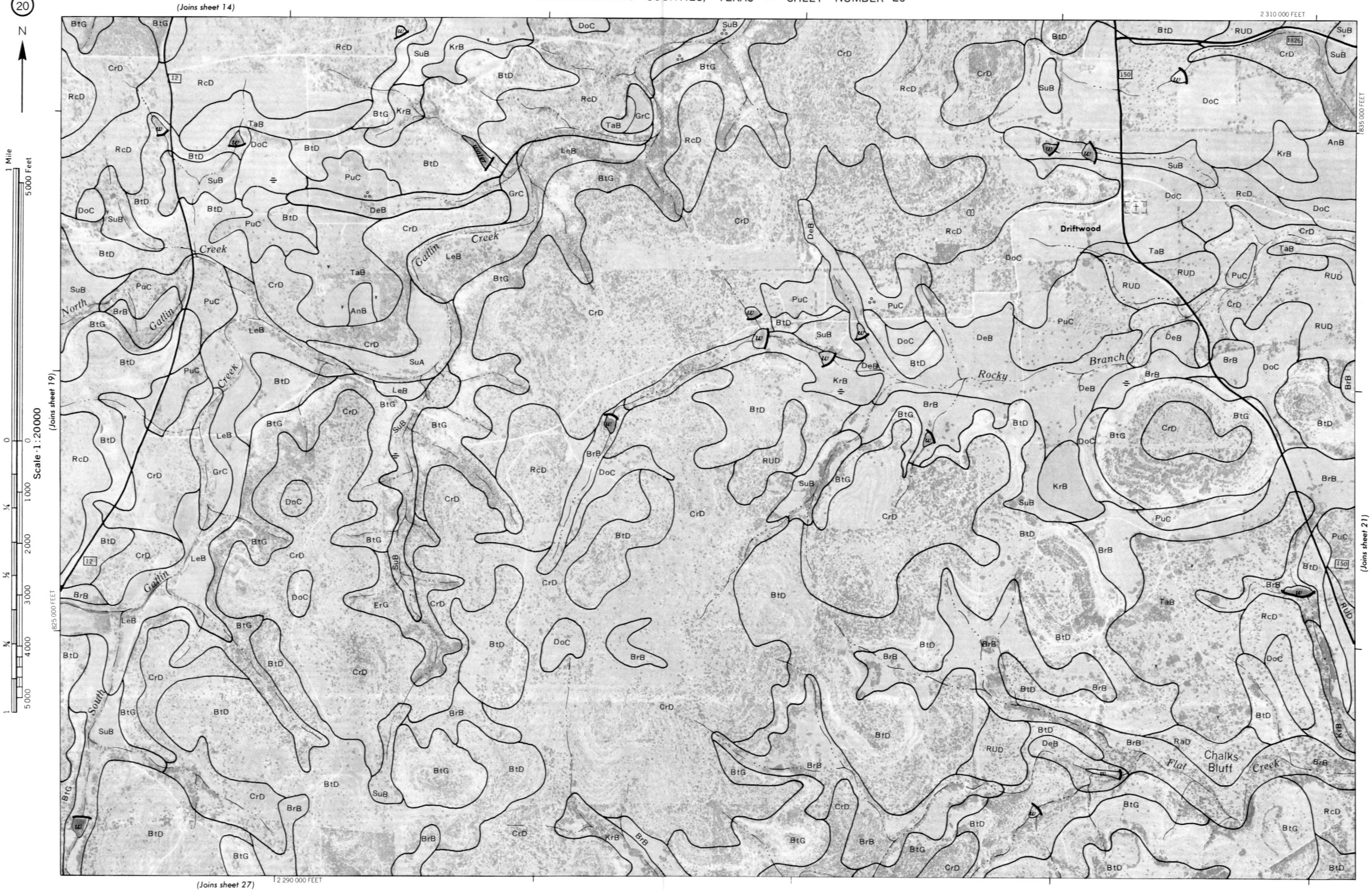

(Joins sheet 11)
2 315 000 FEET
850 000 FEET
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 21)
2 335 000 FEET
840 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Bear
Creek
Spring
Hollow
Friday
Mountain
Little
Bear
Creek
Onion
Creek
water
1826
967


N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000
(Joins inset, sheet 16)
(Joins sheet 15)
(Joins sheet 22)
(Joins inset, sheet 23)
(Joins sheet 11)
(Joins upper left)
4000 AND 5000-FOOT GRID TICKS
2 355 000 FEET
2 335 000 FEET
2 340 000 FEET
850 000 FEET
858 000 FEET
854 000 FEET
840 000 FEET
TRAVIS
COUNTY
Bear
Creek
Little
1826
BtD
LeB
CrD
TaB
RUD
DoC
LeA
DoC
PuC
BtG
BrB
ErG
AnB
KrB
SuB
MEC


17
N
2 215 000 FEET
835 000 FEET
2 231 000 FEET
850 000 FEET
840 000 FEET
2 236 000 FEET
(Joins upper right)
(Joins sheet 12)
(Joins inset, sheet 17)
(Joins sheet 18)
(Joins sheet 24)
820 000 FEET
2 235 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
BLANCO
COUNTY
Onion
Creek
165
2325
water
BtG
BtD
SuB
SeB
RUD
CrD
BrB
DeB
DoC
LeB
KrB
TaB
RcD
PuC


N
(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 25)
2 260 000 FEET
835 000 FEET
820 000 FEET
2 240 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
White Branch
Mustang Branch
Freestone Branch
South Onion Creek
Cypress Creek
Mt. Sharp
2325


19
N
(Joins sheet 13)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
2 265 000 FEET
2 285 000 FEET
835 000 FEET
825 000 FEET
Peach Mountain
Jack Mountain
South Onion Creek
Cat Hollow Creek
North Gatlin Creek
Gatlin Creek
South
COOLEY ROAD
GATLIN ROAD
12
1 Mile
5000 Feet
Scale 1:20000


(Joins sheet 14)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
N
1 Mile
5000 Feet
Scale 1:20000
2 310 000 FEET
2 290 000 FEET
835 000 FEET
825 000 FEET
Driftwood
North Gallin Creek
Gallin Creek
South Gallin
Rocky Branch
Chalks Bluff
Flat Creek
water
12
150
1826


2 315 000 FEET
(Joins sheet 15)
835 000 FEET
(Joins sheet 20)
(Joins sheet 22)
825 000 FEET
(Joins sheet 28)
2 335 000 FEET
Onion Creek
Rocky Branch
Little Bear Creek
Flat Creek
1826
967
150
N
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1

COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 22


(Joins inset)
2 360 000 FEET
835 000 FEET
(Joins sheet 22)
(Joins sheet 30)
2 380 000 FEET
825 000 FEET
TRAVIS
COUNTY
MISSOURI PACIFIC RAILROAD
Little Bear Creek
Garlic
Onion
Creek
Buda
water
1626
967
35
81
4
HeC3
HeB
CrD
DeC3
DeB
RUD
RaD
MED
w
KrB
TaB
DoC
PuC
BrB
SuB
DeC3
GrC
Pt
Or
Tn
MEC
AnB
KrC
LeB
KrA
ErG
SeB
HoB
AgC3
HvB
HeD3
HvD
ByA
ByB
2 360 000 FEET
840 000 FEET
838 000 FEET
2 361 000 FEET
(Joins sheet 16)
(Joins upper left)
1000 AND 2000-FOOT GRID TICKS
N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 17)
(Joins sheet 25)
(Joins sheet 32)
(Joins sheet 40)
2 210 000 FEET
2 205 000 FEET
2 215 000 FEET
2 235 000 FEET
795 000 FEET
790 000 FEET
805 000 FEET
820 000 FEET
BLANCO
COUNTY
Rocky Creek
Wanslow Creek
BLANCO RIVER
The Narrows
BtG
BtD
BrB
CrD
DoC
PuC
KrB
SuB
DeB
TaB
ErG
Oa
AnB


25
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 33)
2 240 000 FEET
2 260 000 FEET
820 000 FEET
805 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
Cypress Creek
Winslow Creek
BLANCO RIVER
Little Blanco River
2325
BtD
BtG
CrD
BrB
DeB
SuB
KrB
RcD
Oa
LeB
TaB
RUD
DoC
ErG
w


(Joins sheet 19)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 34)
N
1 Mile
5 000 Feet
Scale 1:20000
2 285 000 FEET
820 000 FEET
805 000 FEET
2 265 000 FEET
Lone Women Mountain
MT. SHARP
ROAD
COOLEY ROAD
MT. SHARP ROAD
JACOBS WELL ROAD
Cypress
Creek
12

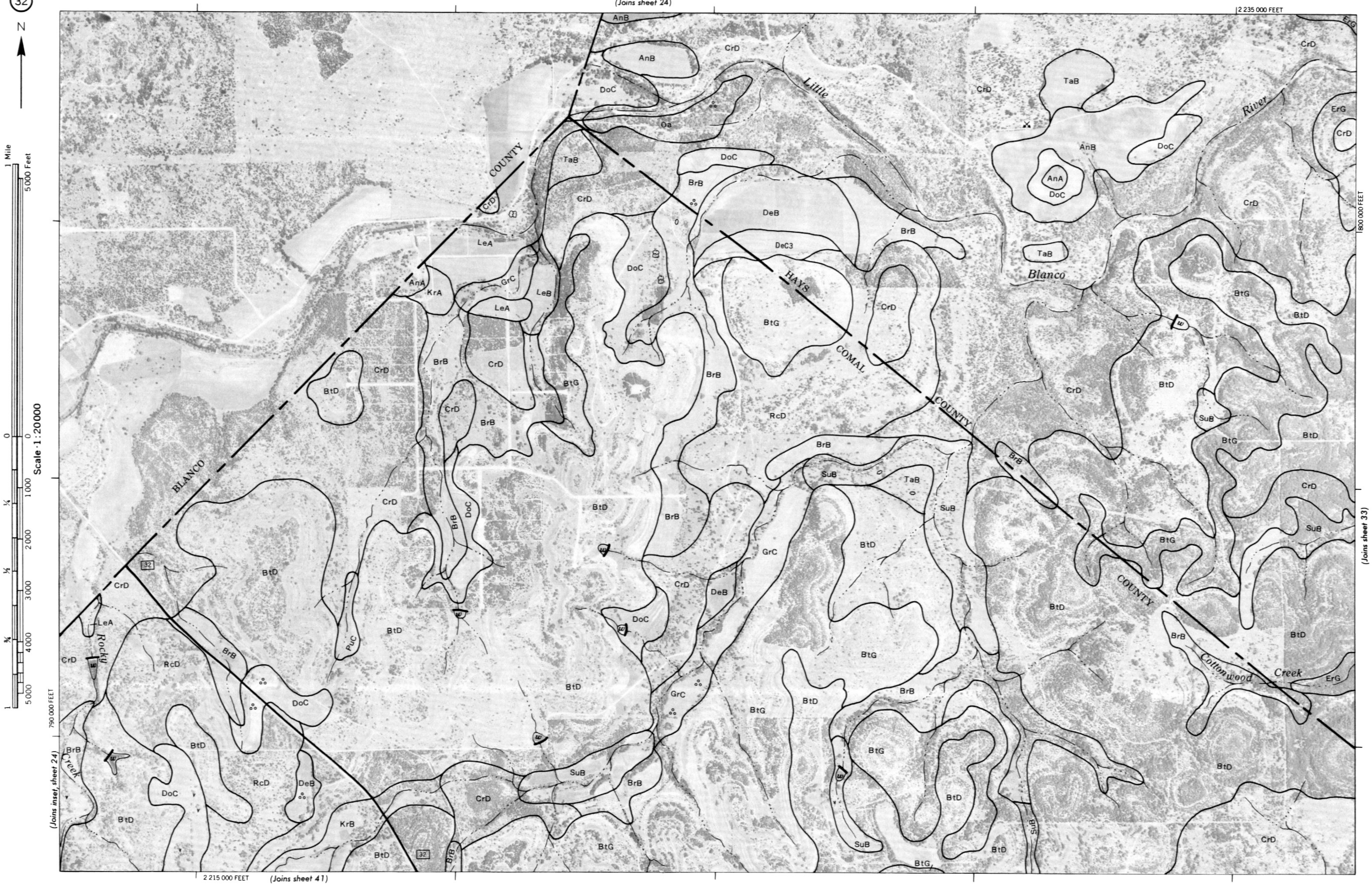

27
N
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 35)
2 290 000 FEET
2 310 000 FEET
820 000 FEET
805 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
Lone Man Mountain
Flat Creek
York Creek
Lone Man Creek
12
3237
SuB
BtD
BrB
BtG
CrD
KrB
RcD
DoC
DeB
TaB
AnB
RUD

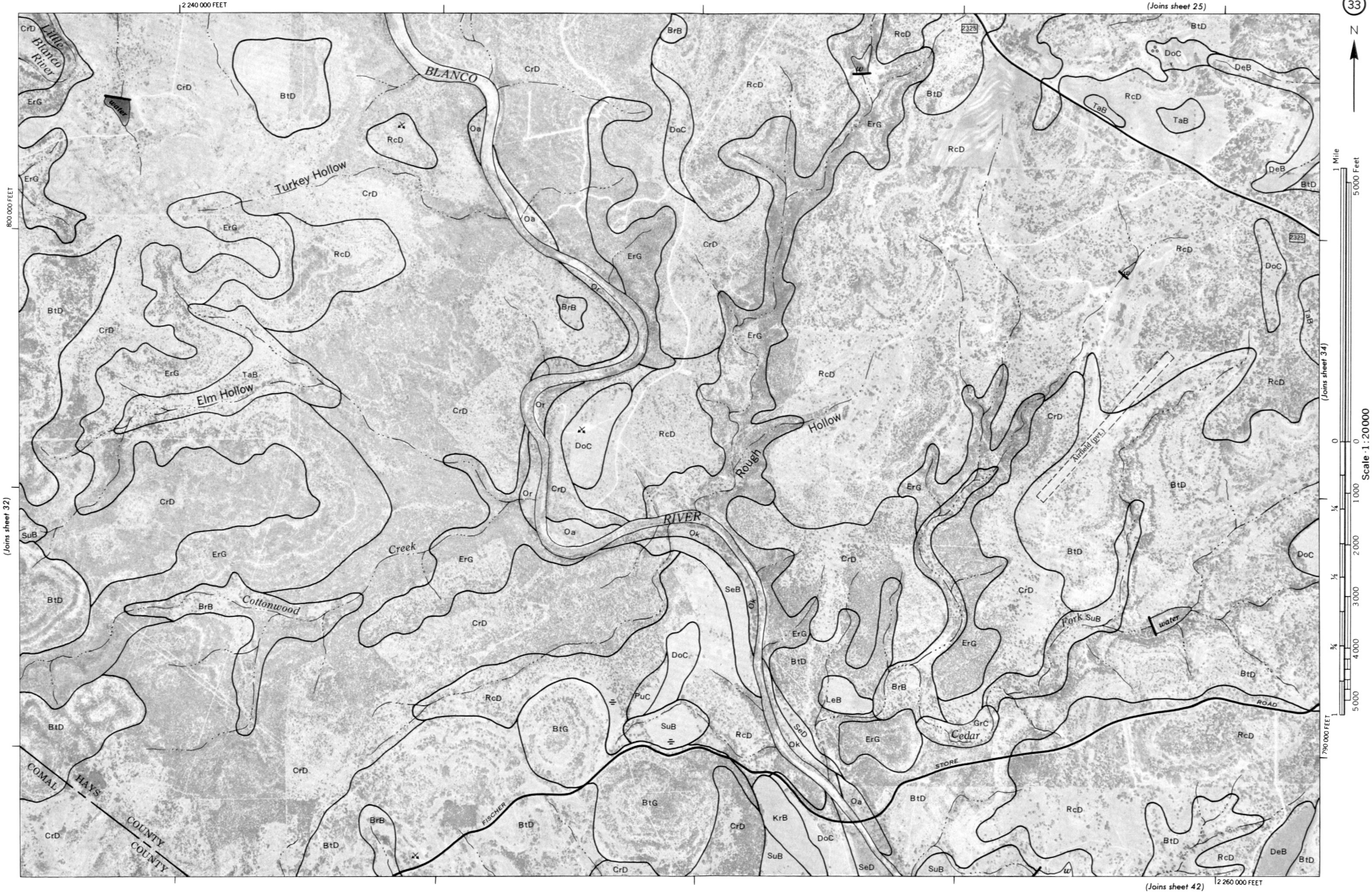

28
N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
(Joins sheet 21)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 36)
2 335 000 FEET
820 000 FEET
805 000 FEET
2 315 000 FEET
BtD
BtG
AnB
Ok
SuA
150
GrC
LeB
SeB
Onion
Creek
ErG
CrD
water
BoB
SuB
Oa
RUD
Airfield (pvt.)
int
w
DeB
RcD
PuC
DoC
York
Creek
TaB
3237
Onion
Creek
Ok
RUD


29
N
(Joins sheet 22)
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 37)
2 340 000 FEET
2 360 000 FEET
820 000 FEET
805 000 FEET
Onion Creek
Mustang Branch
Barton Hill
water
2770
Scale 1:20000
1 Mile
5000 Feet
RUD
TaB
CrD
KrB
KrA
KrC
AnB
DeB
PuC
ErG
GrC
RaD
Pt
BoB
Or
Oa
LeB
LeA
ByA
ByB
SuB
SeB
AuB
AuC3
CaC3
HoB
MEC
MED
int


(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 38)
N
Scale 1:20000
1 Mile
5000 Feet
2 380 000 FEET
2 360 000 FEET
820 000 FEET
805 000 FEET
Buda
TRAVIS COUNTY
Onion Creek
Bunton Branch
Richmond Branch
Andrews Branch
Brushy Creek
MISSOURI PACIFIC RAILROAD
water

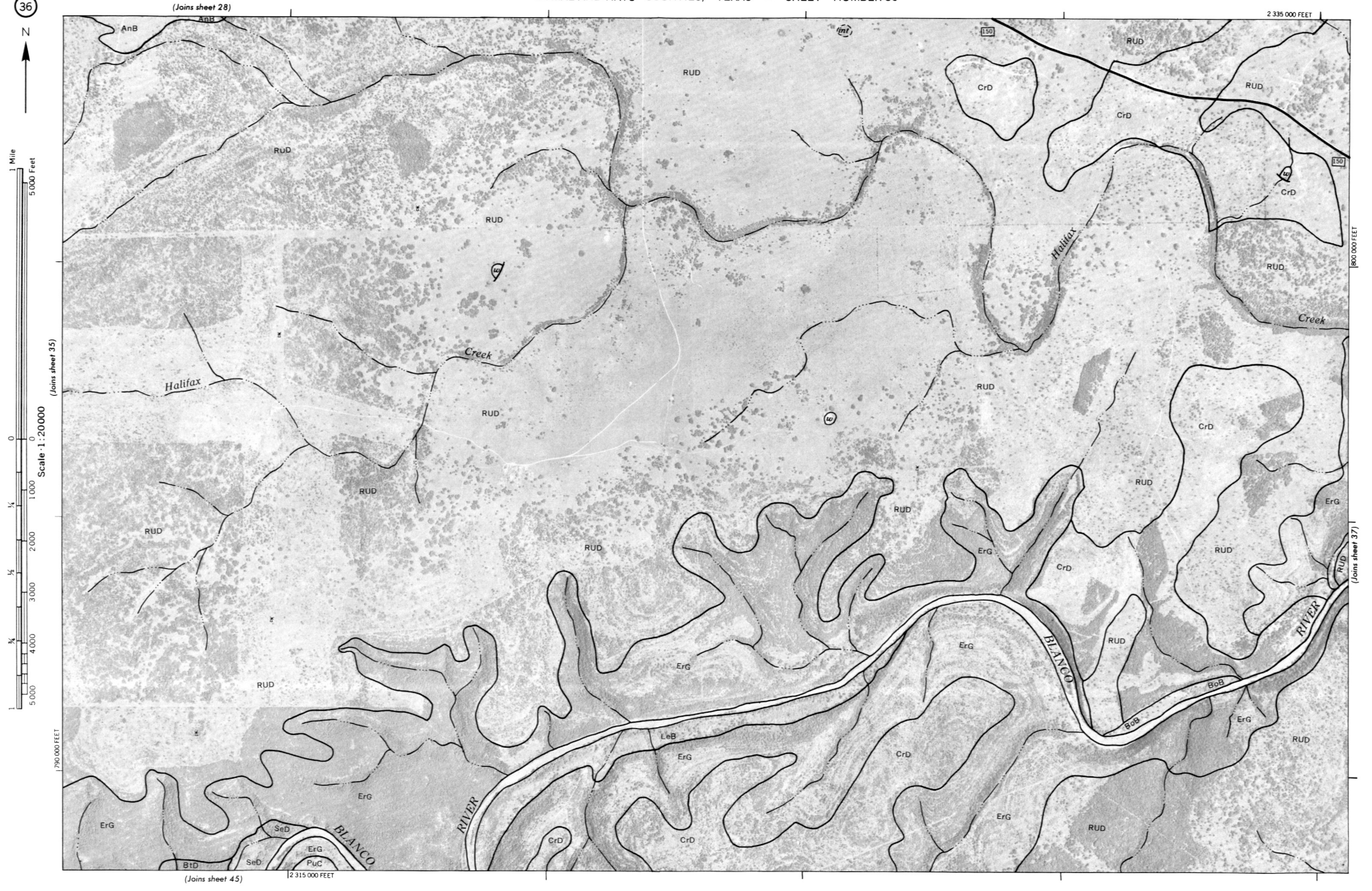

31
N
2 385 000 FEET
820 000 FEET
805 000 FEET
2 405 000 FEET
(Joins sheet 30)
(Joins sheet 39)
TRAVIS
COUNTY
Brushy
Creek
water
water
HeD3
AgC3
HeB
AgC3
HeB
Tn
HeC3
HoB
HeC3
AgC3
AgD3
AgD3
HeC3
HeD3
HoB
HoB
AgC3
HeC3
HoB
HeD3
HeD3
HoB
Tn
FeF4
FeF4
HeD3
FeF4
HvB
HeC3
HvD
HoB
HvB
FeF4
HeD3
HoB
HeD3
HeD3
HeB
Tn
HeC3
HgD
HeC3
HvD
FeF4
HgD
HeC3
HoB
HgD
HoB
HgD
HeC3
Tn
HeD3
HoB
HvB
FeF4
HvB
HoB
HoB
HvD
FeF4
FeF4
HvB
ByA
HeB
HvD
HoB
HgD
HgD
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
0
1000
2000
3000
4000
5000


(Joins sheet 24)
N
1 Mile
5 000 Feet
Scale 1:20 000
2 235 000 FEET
800 000 FEET
790 000 FEET
2 215 000 FEET
(Joins sheet 41)
(Joins sheet 33)
(Joins inset, sheet 24)
COUNTY
BLANCO
HAYS
COMAL
Little
River
Blanco
Rocky
Creek
Cottonwood
32
AnB
CrD
DoC
Oa
TaB
LeA
AnA
KrA
GrC
LeB
BrB
DeB
DeC3
BtG
BtD
RcD
SuB
PuC
KrB
ErG


2 240 000 FEET
(Joins sheet 25)
800 000 FEET
(Joins sheet 32)
(Joins sheet 34)
790 000 FEET
2 260 000 FEET
(Joins sheet 42)
N
1 Mile
5000 Feet
Scale 1:20000
Little Blanco River
BLANCO
RIVER
Turkey Hollow
Elm Hollow
Rough Hollow
Cottonwood Creek
Cedar Fork
Airfield (pvt.)
FISCHER STORE ROAD
2325
COMAL COUNTY
HAYS COUNTY
water
w
CrD
ErG
BtD
RcD
Oa
Or
Ok
DoC
BrB
TaB
DeB
SuB
SeB
SeD
PuC
BtG
LeB
GrC
KrB

COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 34

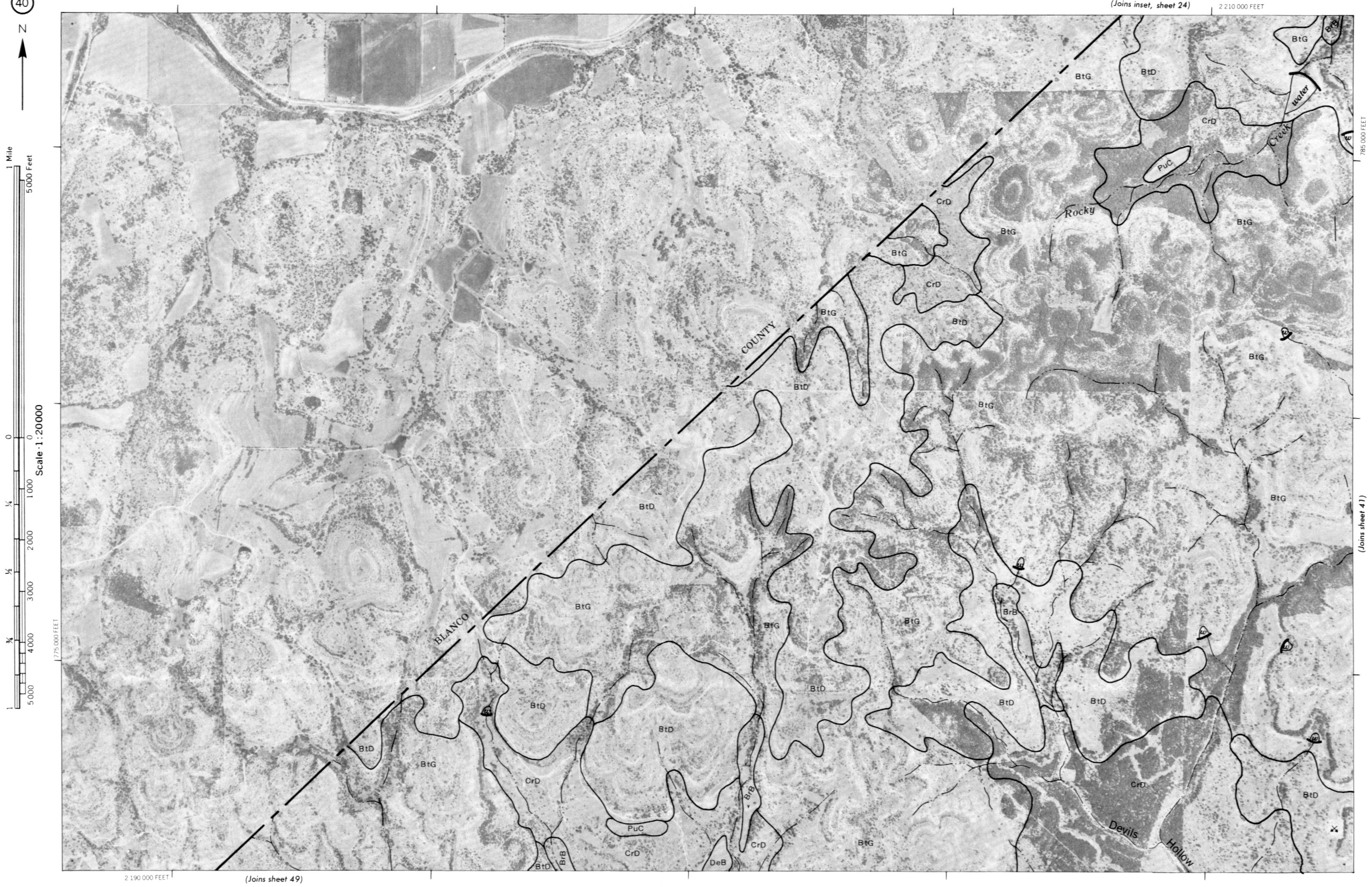

(Joins sheet 27)
(Joins sheet 34)
(Joins sheet 36)
(Joins sheet 44)
2 285 000 FEET
2 310 000 FEET
800 000 FEET
790 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
Lone Man Creek
Smith Creek
Cypress Creek
Eagle Mountain
Air Strip
3237
BtG
BtD
CrD
DoC
BrB
KrB
PuC
RcD
SuB
LeB
Or
Ok
GrC
BrB
RUD
TaB
DeB
ErG

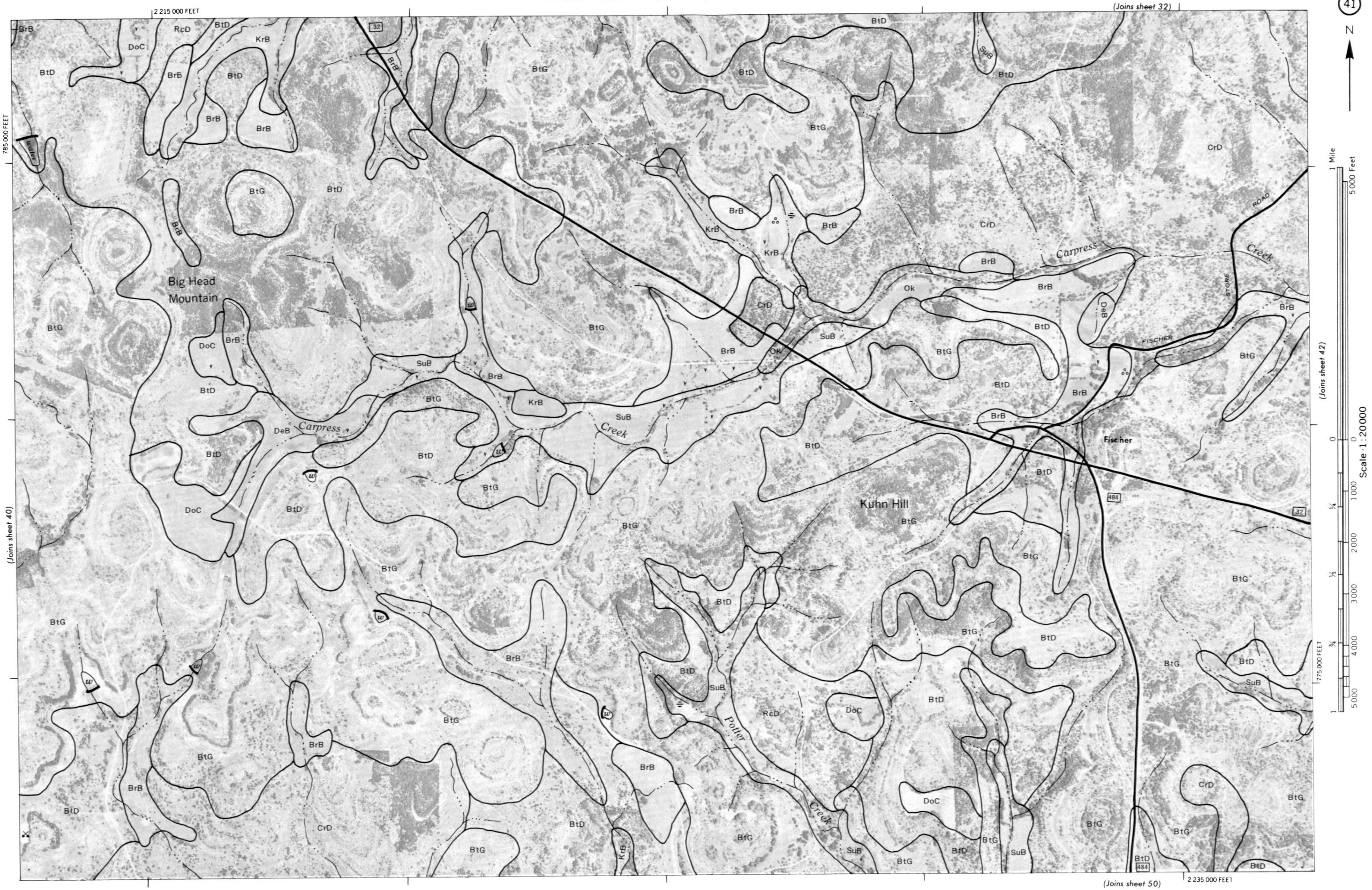

N
(Joins sheet 28)
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 45)
2 335 000 FEET
2 315 000 FEET
800 000 FEET
790 000 FEET
Scale 1:20000
1 Mile
5 000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
AnB
RUD
CrD
ErG
LeB
BoB
SeD
BtD
PuC
150
Halifax
Creek
BLANCO
RIVER


37
N
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 46)
2 340 000 FEET
2 360 000 FEET
790 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Mustang
Branch
Blanco
River
Plum
Creek
water
MISSOURI
PACIFIC
RAILROAD
KYLE
150
2770
35
81
RUD
CrD
TaB
KrB
MEC
RaD
DoC
AuB
HoB
ByA
Tn
PuC
CaC3
AuC3
CrD
DeB
ErG
BoB
KrC
LeB
KrA
HeB
CaC3

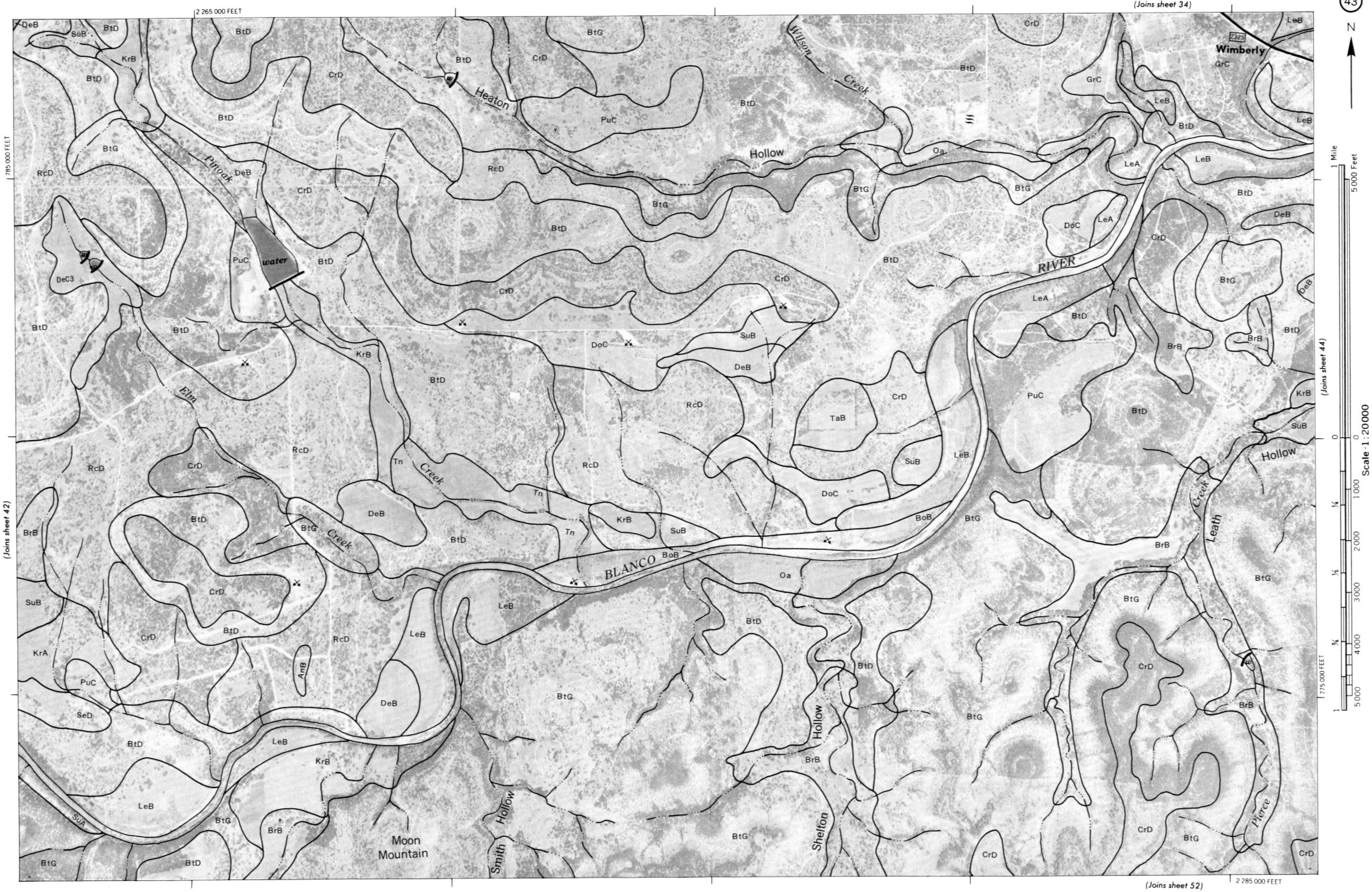

(Joins sheet 30)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 47)
N
1 Mile
5 000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
¼
½
¾
1
2 380 000 FEET
805 000 FEET
790 000 FEET
2 360 000 FEET
MISSOURI PACIFIC RAILROAD
35
81
4
2001
Richmond Branch
Andrews Branch
Porter Creek
Bunton Branch
Plum Creek
water
AgC3
AuB
AuC3
ByA
ByB
CaC3
FeF4
HeB
HeC3
HeD3
HgD
HoB
HvB
HvD
LeB
RaD
Tn
w


39
N
(Joins sheet 31)
(Joins sheet 38)
(Joins inset, sheet 101)
2 385 000 FEET
805 000 FEET
2 405 000 FEET
790 000 FEET
TRAVIS
COUNTY
CALDWELL
COUNTY
Niederwald
Brushy
Creek
Elm
Creek
intermittent
water
2001
2083
21
1 Mile
5 000 Feet
Scale 1:20000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
HoB
HeB
HeD3
HeC3
HgD
HvB
HvD
ByA
ByB
FeF4
Tn
AgD3
AgC3
LeB
w


N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
(Joins inset, sheet 24)
2 210 000 FEET
785 000 FEET
(Joins sheet 41)
775 000 FEET
2 190 000 FEET
(Joins sheet 49)
BLANCO
COUNTY
Rocky
Creek
water
Devils
Hollow
BtG
BtD
CrD
PuC
BrB
DeB


2 215 000 FEET
(Joins sheet 32)
785 000 FEET
(Joins sheet 40)
(Joins sheet 42)
775 000 FEET
(Joins sheet 50)
2 235 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Big Head Mountain
Kuhn Hill
Fischer
Carpress Creek
Potter Creek
FISCHER STORE ROAD
32
484
BtD
BtG
BrB
KrB
DoC
RcD
CrD
SuB
DeB
Ok
w
water


(Joins sheet 33)
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 51)
N
1 Mile
5 000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
2 260 000 FEET
785 000 FEET
775 000 FEET
2 240 000 FEET
FISCHER STORE ROAD
32
COMAL
HAYS
BLANCO
COUNTY
RIVER
Carpers Creek
Sorrel Creek
Dutch Branch
water
CrD
BtD
BtG
RcD
DoC
SuB
BrB
KrB
KrC
SeB
SeD
SuA
PuC
TaB
GrC
BoB
DeB
Oa
Or


(Joins sheet 34)
(Joins sheet 44)
(Joins sheet 52)
(Joins sheet 42)
2 265 000 FEET
2 285 000 FEET
785 000 FEET
775 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
Wimberly
2325
Heaton
Hollow
Wilson
Creek
Pinoak
Elm
Creek
BLANCO
RIVER
Leath
Creek
Hollow
Pierce
Shelton
Hollow
Smith
Hollow
Moon
Mountain
water
BtD
BtG
CrD
RcD
DeB
DeC3
PuC
KrB
KrA
SuB
SuA
LeB
LeA
DoC
GrC
BrB
BoB
Oa
TaB
Tn
SeD
AnB


(Joins sheet 35)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 53)
N
1 Mile
5 000 Feet
Scale 1:20000
2 310 000 FEET
785 000 FEET
775 000 FEET
2 290 000 FEET
Wimberly
Eagle Mountain
Cypress Creek
Hollow Creek
BLANCO RIVER
Flight Acres
Leath Pierce
Creek
Spoke Pile
Lone Man Creek
Sycamore Creek
Water
3237
12
LeB
BtG
BtD
GrC
CrD
ErG
DeB
KrB
SuB
PuC
DoC
TaB
SeD
SeB
BrB
BoB
KrC
RUD


45
2 315 000 FEET
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 54)
785 000 FEET
775 000 FEET
2 335 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
1000
2000
3000
4000
5000
Lone Man Creek
BLANCO RIVER
Sycamore Creek
HILLIARD ROAD
ErG
BrB
BtD
LeB
CrD
SeD
BtG
PuC
RUD
MEC
KrB
MED
AnB
Pt
RaD
TaB
DoC
BeB
int

COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 46

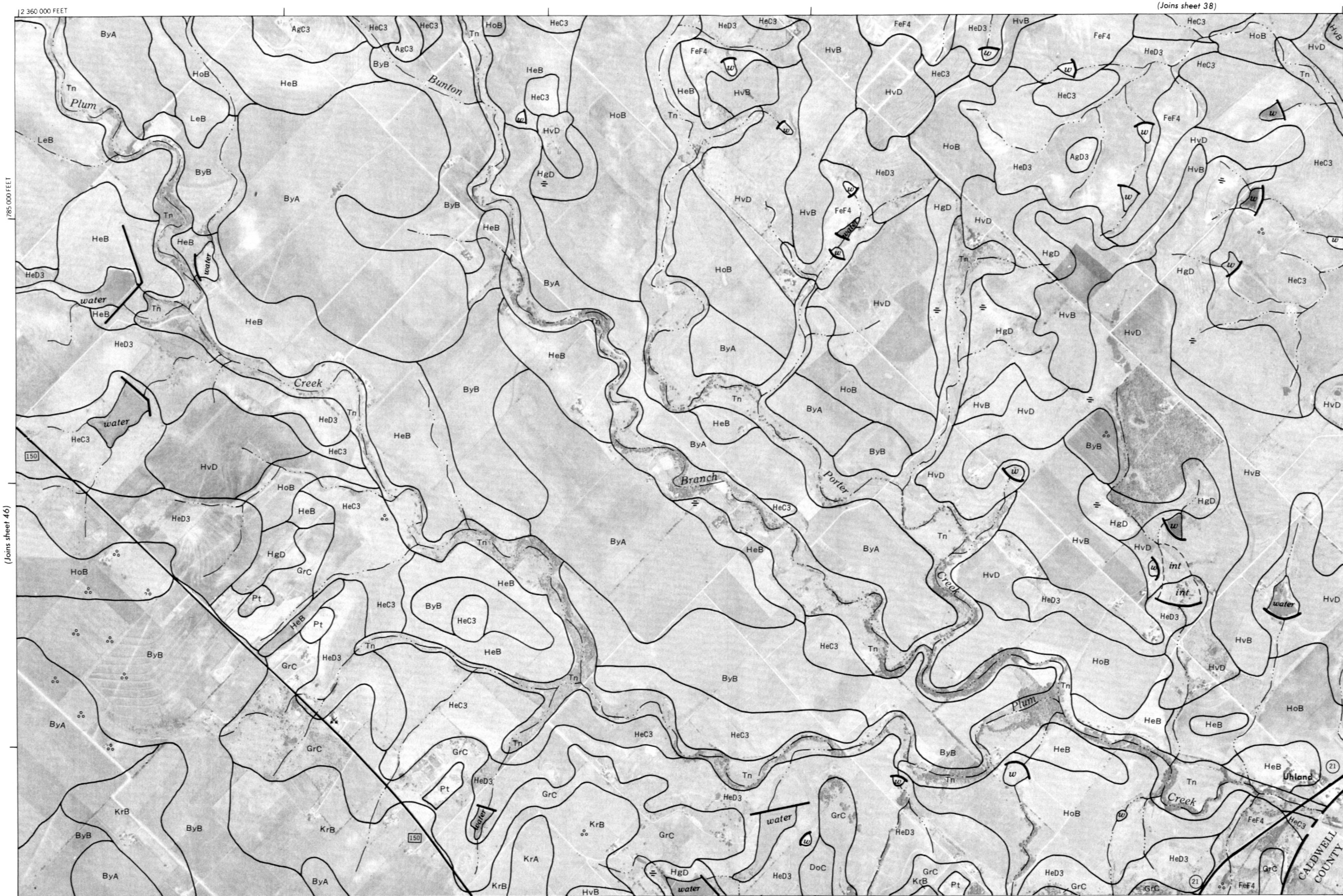
N

2 360 000 FEET

(Joins sheet 38)

785 000 FEET

(Joins sheet 46)




(Joins inset, sheet 101)

1 Mile

5000 Feet

0

1/4

1/2

3/4

1

0

1000

2000

3000

4000

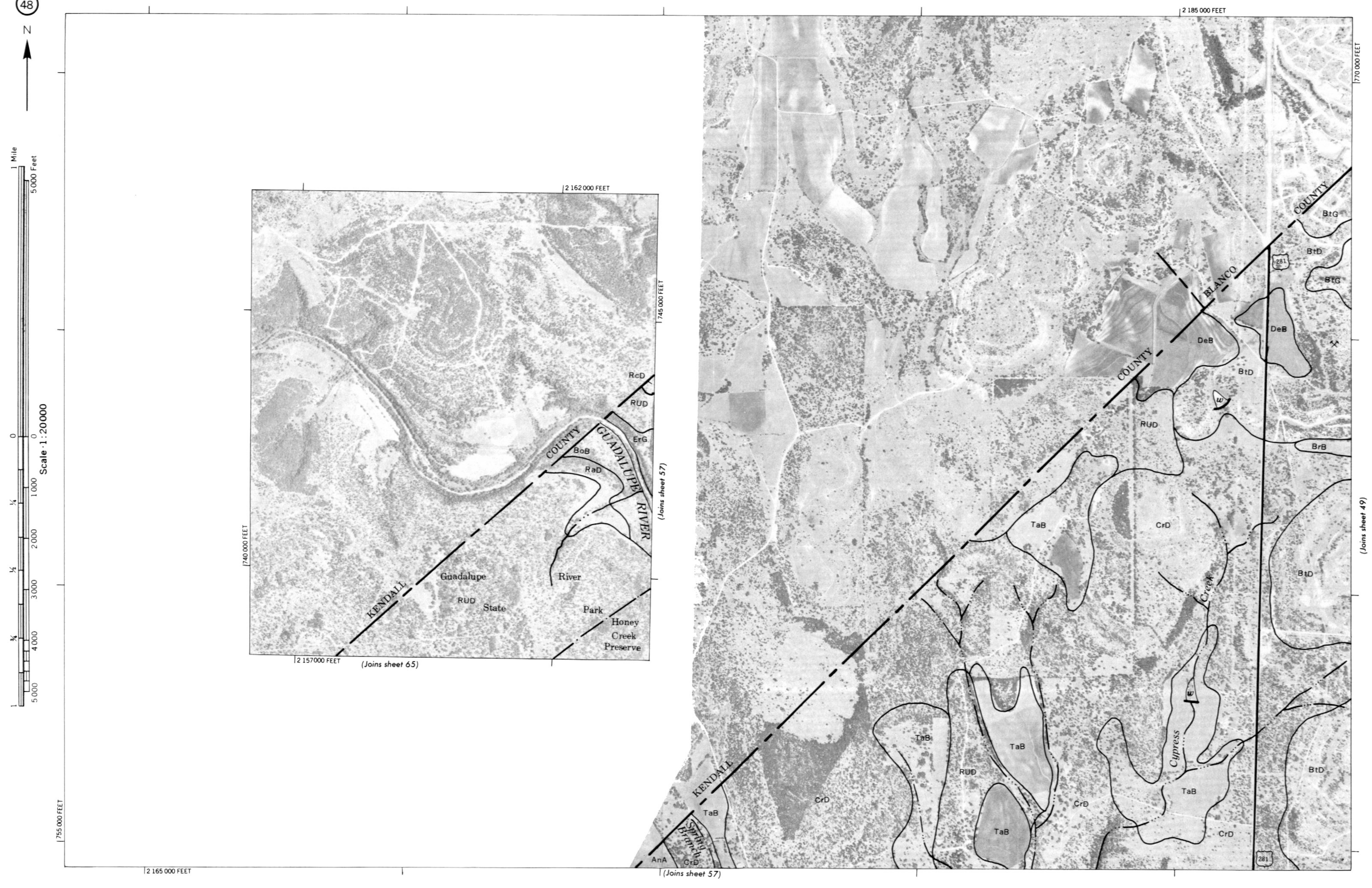
5000

Scale 1:20000

775 000 FEET

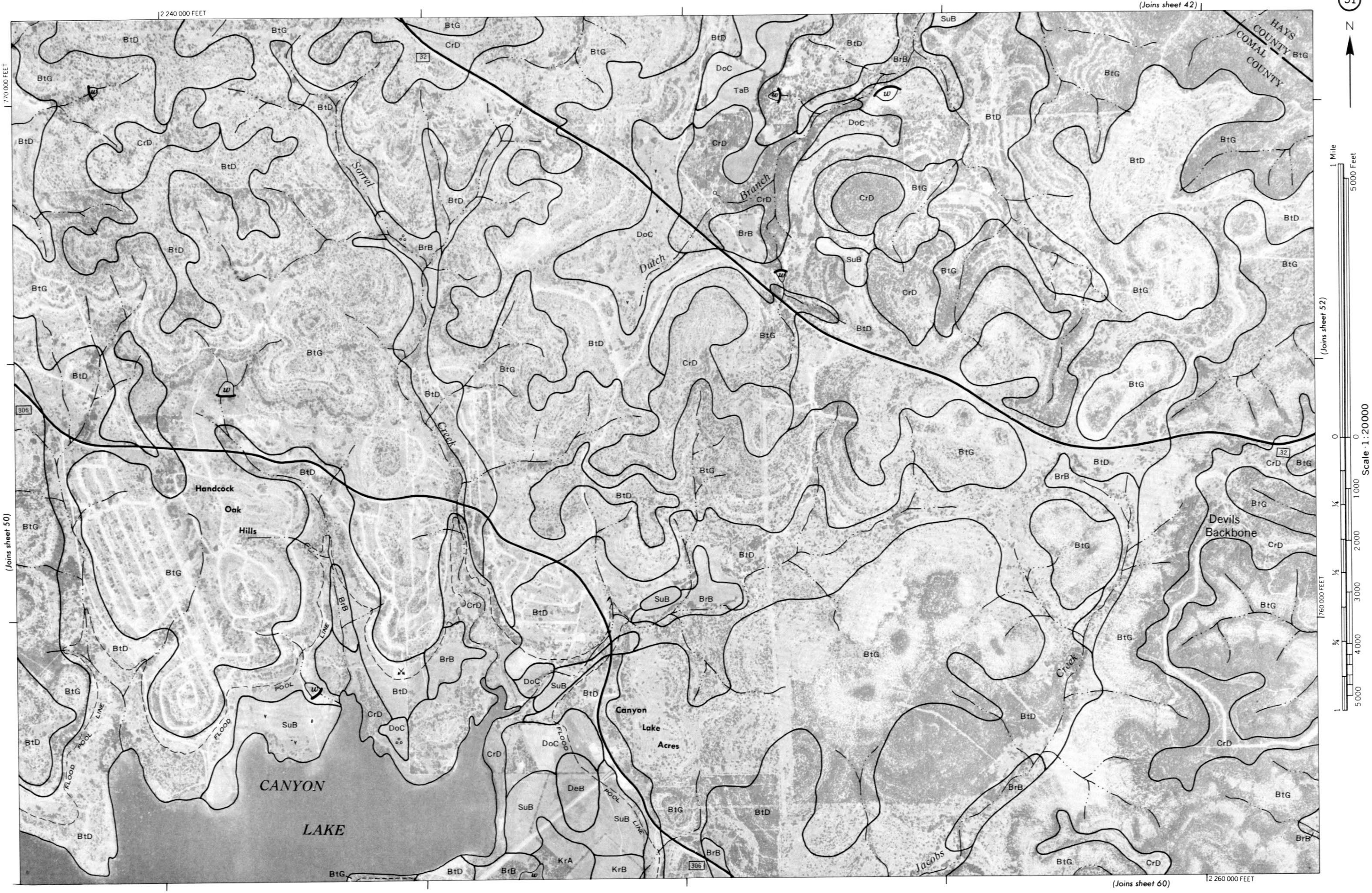
2 385 000 FEET

(Joins sheet 56)

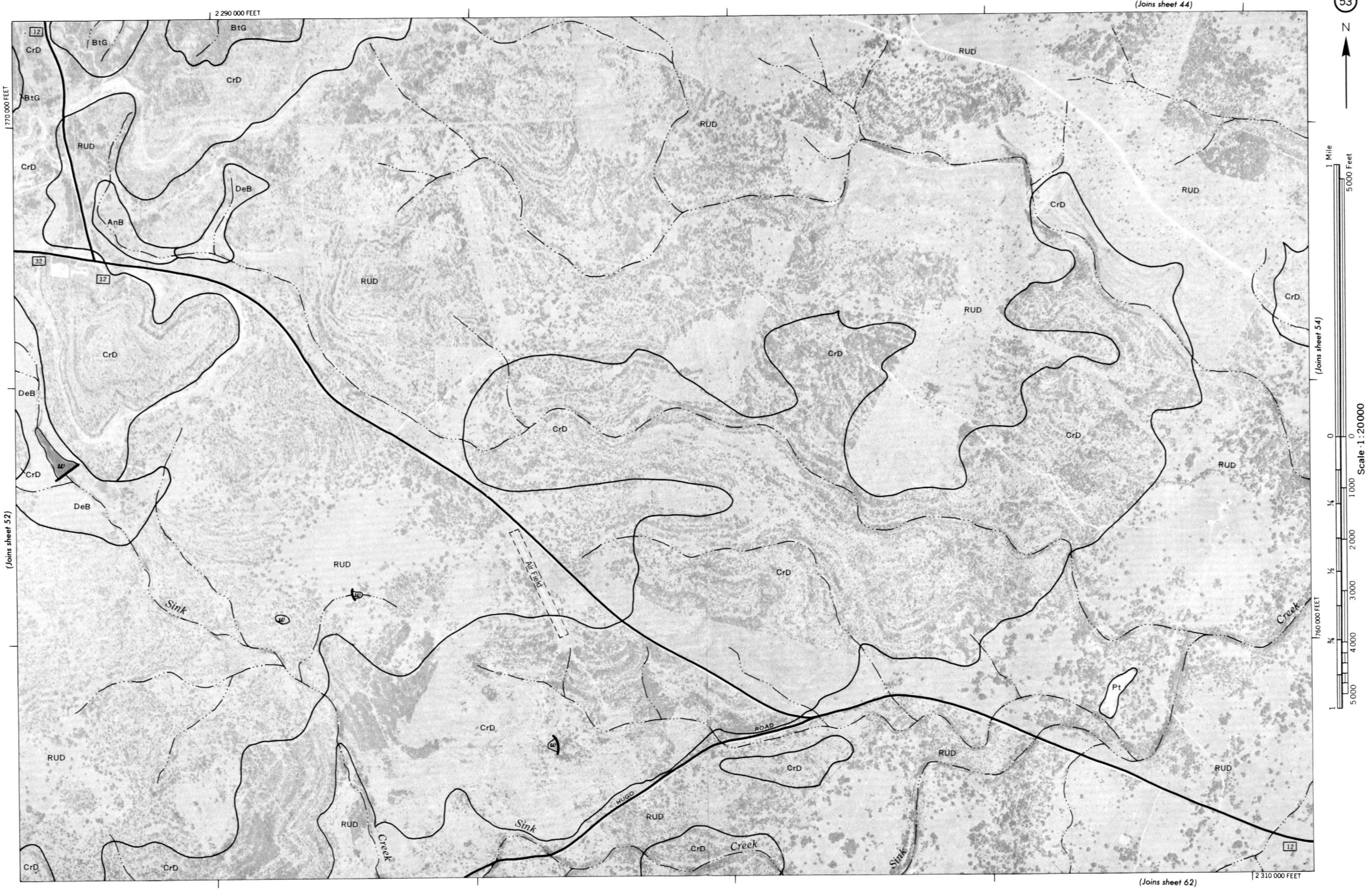

N
1 Mile
5 000 Feet
0
Scale 1:20000
2 162 000 FEET
745 000 FEET
740 000 FEET
2 157 000 FEET
(Joins sheet 65)
(Joins sheet 57)
RcD
RUD
ErG
BoB
RaD
COUNTY
GUADALUPE
RIVER
KENDALL
Guadalupe
RUD
State
River
Park
Honey
Creek
Preserve
2 185 000 FEET
770 000 FEET
COUNTY
BtG
BtD
281
BLANCO
DeB
BtD
RUD
BrB
TaB
CrD
Creek
(Joins sheet 49)
Cypress
TaB
RUD
CrD
KENDALL
TaB
Spring Branch
AnA
CrD
755 000 FEET
2 165 000 FEET
(Joins sheet 57)


49
N
2 190 000 FEET
770 000 FEET
(Joins sheet 40)
(Joins sheet 48)
(Joins sheet 50)
(Joins sheet 58)
2 210 000 FEET
755 000 FEET
1 Mile
5000 Feet
0
¼
½
¾
1
1000
2000
3000
4000
5000
Scale 1:20000
BLANCO
COUNTY
water
Airfield (pvt.)
Rebecca
Creek
Pafor
Cherry
Schultz
Devils
Hollow
Cypress
Cove
GUADALUPE
RIVER
FLOOD POOL LINE
BtG
DeB
BrB
CrD
BtD
Pt
SuB
KrC
PuC
DoC
ErG
LeB
SeB
SuA
RcD
GrC
w


50
N
(Joins sheet 41)
2 235 000 FEET
770 000 FEET
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 59)
2 215 000 FEET
755 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
CrD
BtD
BtG
KrB
DoC
KrC
BrB
SuB
RcD
TaB
Oa
LeB
Or
ErG
484
306
Potter
Creek
Canyon
Lake
Shores
FLOOD
POOL
LINE
GUADALUPE
RIVER
Demijohn
Bend
SuA
SeB
SeD
BoB
CANYON LAKE
CANYON
LAKE
Lakewood
Hills


51
2 240 000 FEET
770 000 FEET
(Joins sheet 42)
(Joins sheet 52)
(Joins sheet 50)
(Joins sheet 60)
760 000 FEET
2 260 000 FEET
HAYS COUNTY
COMAL COUNTY
N
Scale 1:20000
1 Mile
5000 Feet
0
¼
½
¾
1
1000
2000
3000
4000
5000
Sorrel
Creek
Dutch
Branch
Jacobs
Creek
Handcock
Oak
Hills
Canyon
Lake
Acres
CANYON
LAKE
Devils
Backbone
FLOOD
POOL
LINE
32
306
BtD
BtG
CrD
DoC
TaB
BrB
SuB
DeB
KrA
KrB
w

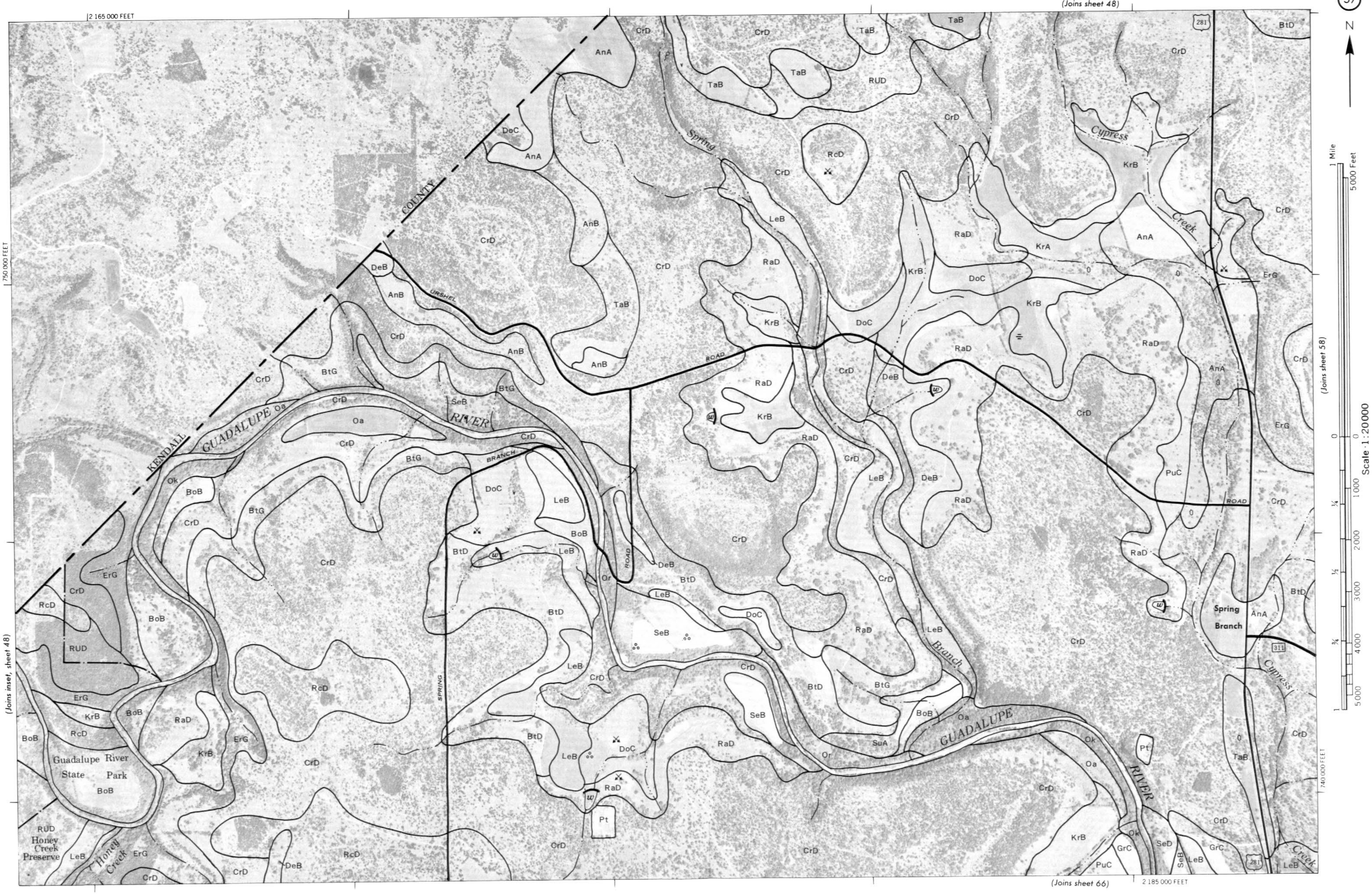

52
N
(Joins sheet 43)
2 285 000 FEET
770 000 FEET
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 61)
2 265 000 FEET
760 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Tower Hill
Smith Hollow
Shelton Hollow
Devils Backbone
COMAL
HAYS
COUNTY
COUNTY
PURGATORY
ROAD
HUGO
ROAD
Purgatory
Creek
32
BtG
BtD
BrB
PuC
CrD
AnB
DeB
TaB
RUD
w


53
N
2 290 000 FEET
(Joins sheet 44)
770 000 FEET
(Joins sheet 52)
(Joins sheet 54)
760 000 FEET
(Joins sheet 62)
2 310 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
12
32
BtG
CrD
RUD
DeB
AnB
Pt
Air Field
Sink
Creek
HUGO
ROAD


54
N
(Joins sheet 45)
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 63)
2 335 000 FEET
2 315 000 FEET
770 000 FEET
760 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
HILLIARD
ROAD
Sink
Creek
12
RUD
CrD
TaB
int
w
MEC
MED
KrB
AnA
AnB
ErG
DoC
PuC
HeB
DeB
DeC3
Or

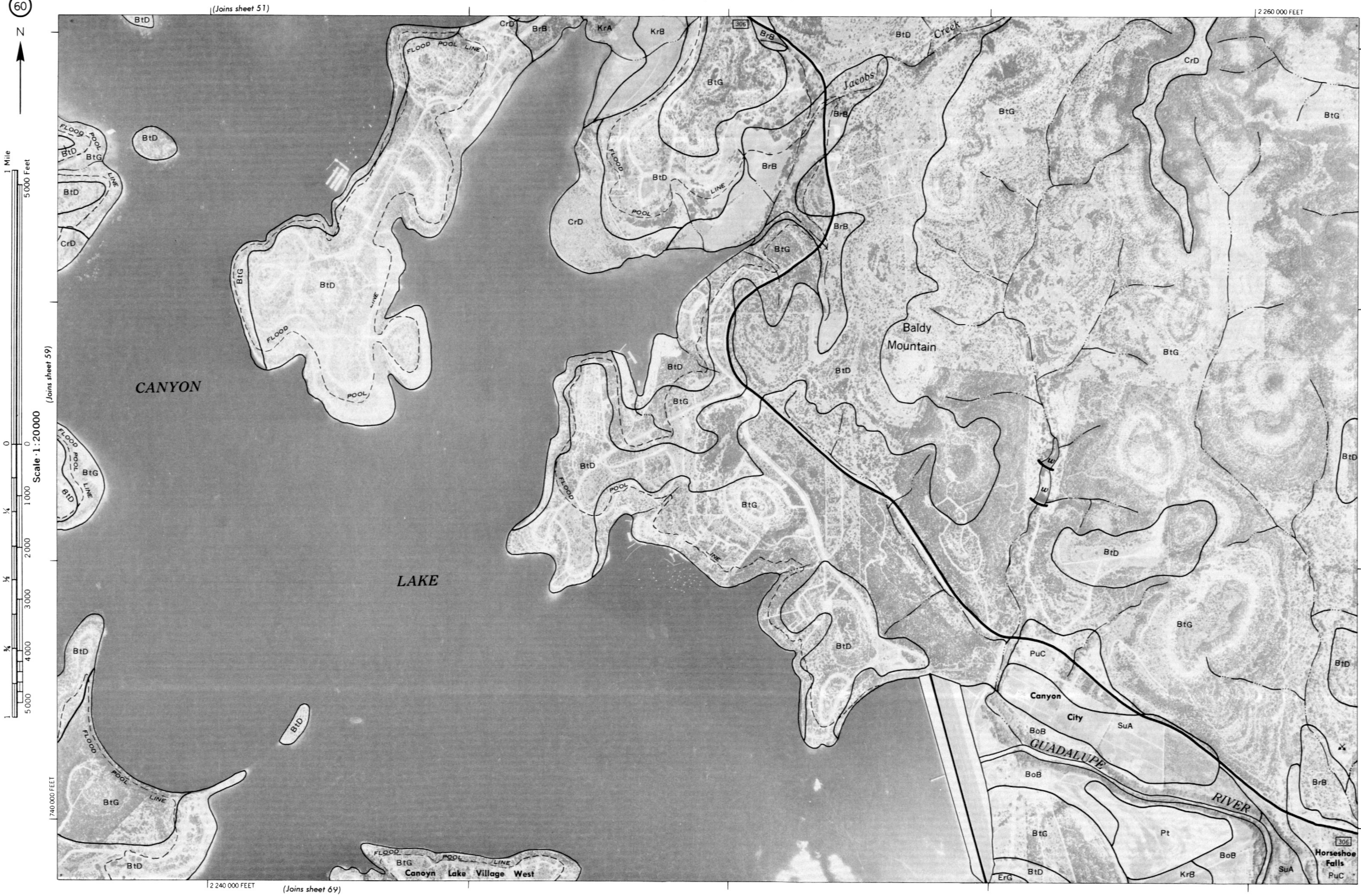

(Joins sheet 46)
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 64)
2 340 000 FEET
2 360 000 FEET
770 000 FEET
760 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
SAN MARCOS
(county seat)
BLANCO
RIVER
Clear
Fork
Plum
Creek
LIME
KILN
ROAD
HILLIARD
ROAD
RAILROAD
PACIFIC
MISSOURI
81
35
int

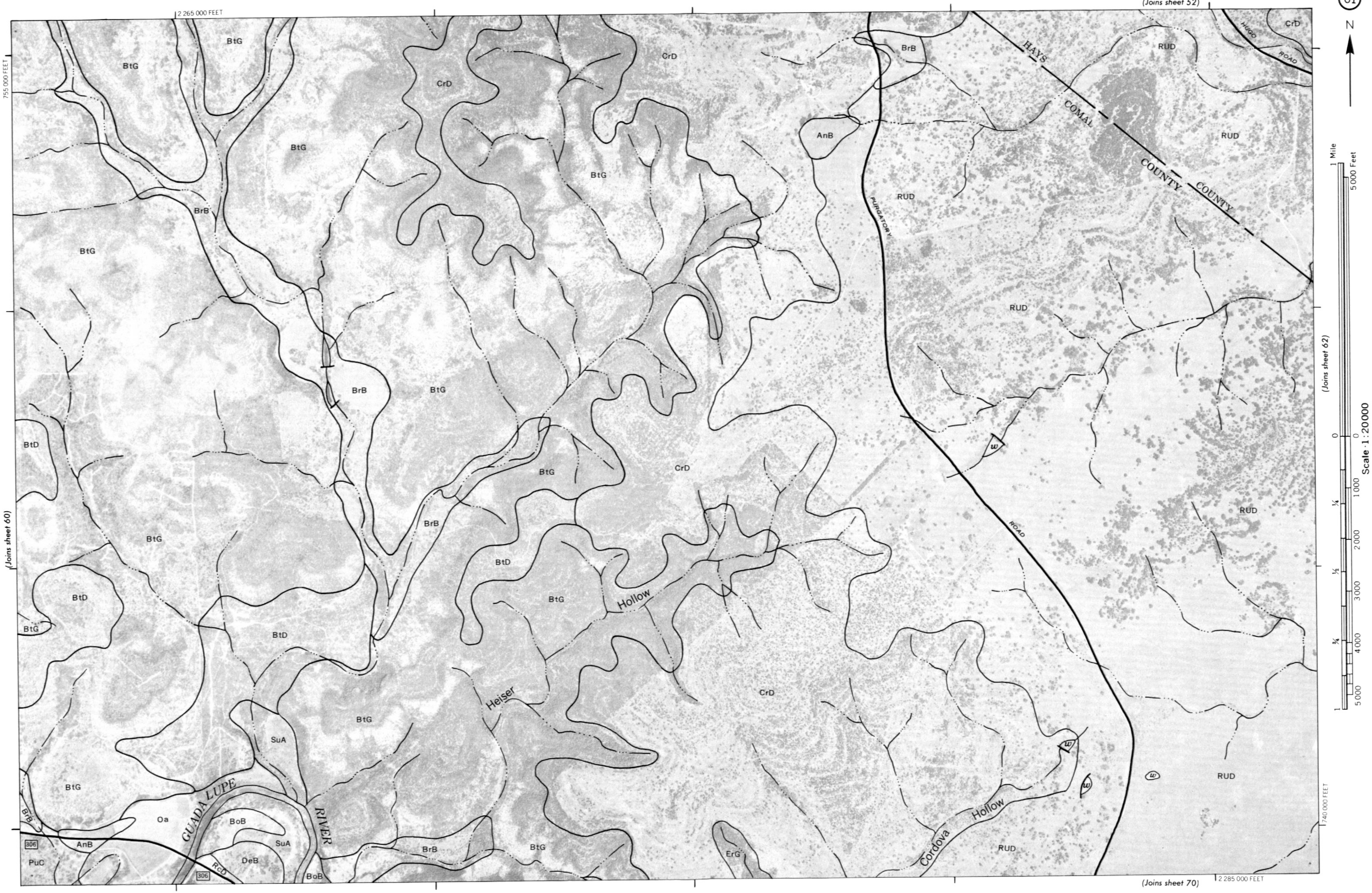

56
N
(Joins sheet 47)
(Joins sheet 55)
(Joins inset)
2 385 000 FEET
770 000 FEET
760 000 FEET
2 360 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Clear Fork
Plum Creek
CALDWELL COUNTY
water
150
21
ByA
ByB
KrA
KrB
GrC
HvB
HvD
HgD
HeD3
HeC3
HeB
HoB
DoC
Pt
FeF4
LeA
LeB
Tn
w
(Joins lower left)
2 364 000 FEET
(Joins sheet 64)
756 000 FEET
754 000 FEET
2 360 000 FEET
2000 AND 4000-FOOT GRID TICKS


57
N
(Joins sheet 48)
(Joins sheet 58)
(Joins sheet 66)
(Joins inset, sheet 48)
2 165 000 FEET
750 000 FEET
740 000 FEET
2 185 000 FEET
KENDALL
COUNTY
GUADALUPE
RIVER
URSHEL
ROAD
SPRING
BRANCH
Spring
Cypress
Creek
Spring Branch
Guadalupe River State Park
RUD Honey Creek Preserve
Honey Creek
281
311
CrD
AnA
AnB
DoC
DeB
TaB
RUD
RcD
LeB
RaD
KrB
KrA
ErG
BtG
BtD
SeB
Oa
Ok
Or
BoB
Pt
PuC
SuA
GrC
SeD
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

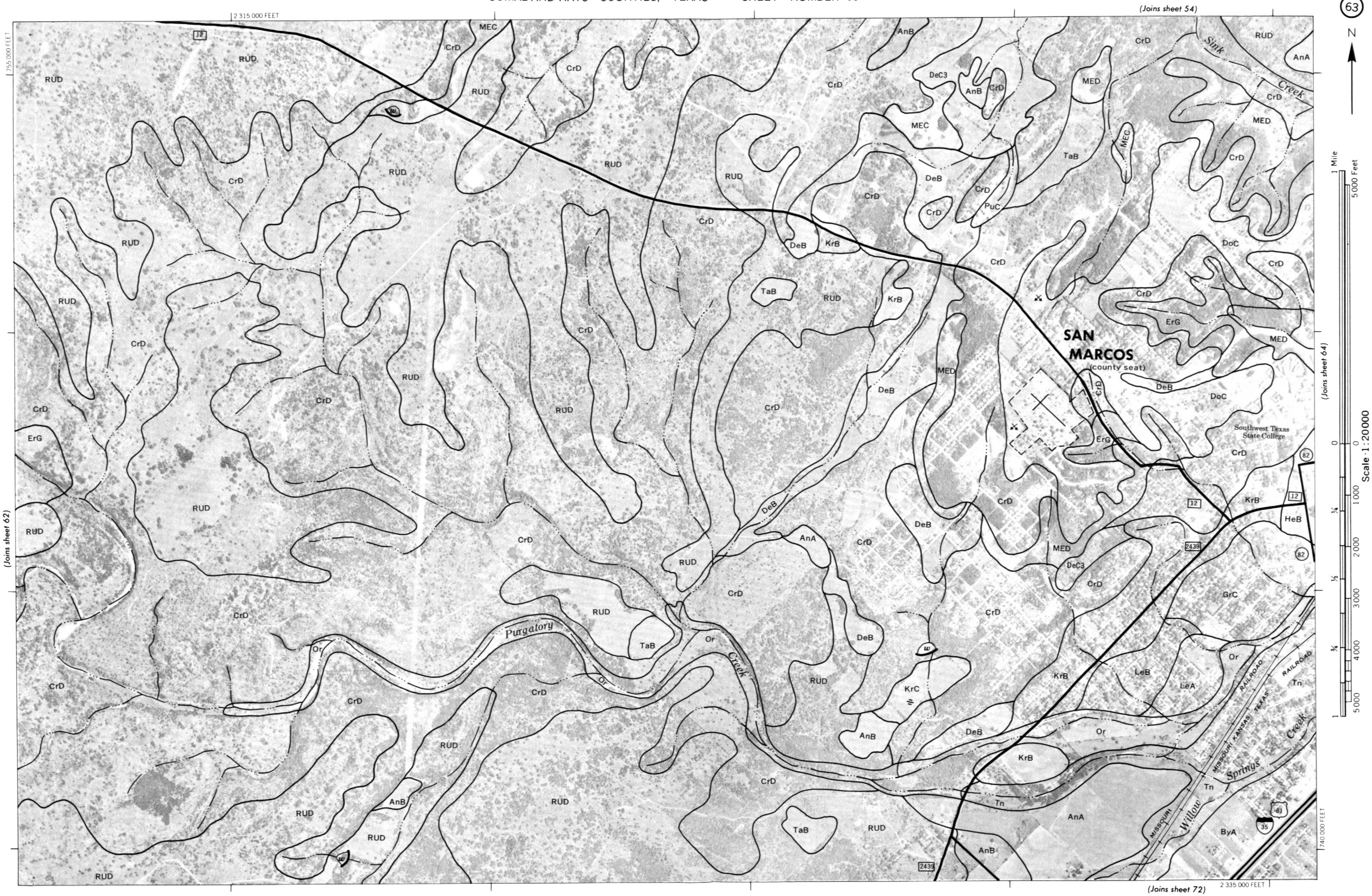

N
(Joins sheet 49)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 67)
2 210 000 FEET
755 000 FEET
740 000 FEET
2 190 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
GUADALUPE
RIVER
FLOOD POOL LINE
Airfield
water
311
BtD
CrD
ErG
BtG
TaB
BrB
SeD
SeB
LeB
DoC
SuA
RcD
BoB
PuC
SuB
KrC
KrB
Pt


59
N
(Joins sheet 50)
(Joins sheet 60)
(Joins sheet 58)
(Joins sheet 68)
2 215 000 FEET
2 235 000 FEET
755 000 FEET
740 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
GUADALUPE
RIVER
Cardova
Bend
CANYON
LAKE
CANYON
LAKE
CANYON
LAKE
Creek
Jentsch
Lake
View
Park
Canyon
Lake
Mobil
Home
Estates
2673
FLOOD
POOL
LINE
SeD
SeB
BtD
BtG
CrD
ErG
PuC
BrB
RcD
DoC
SuB
w

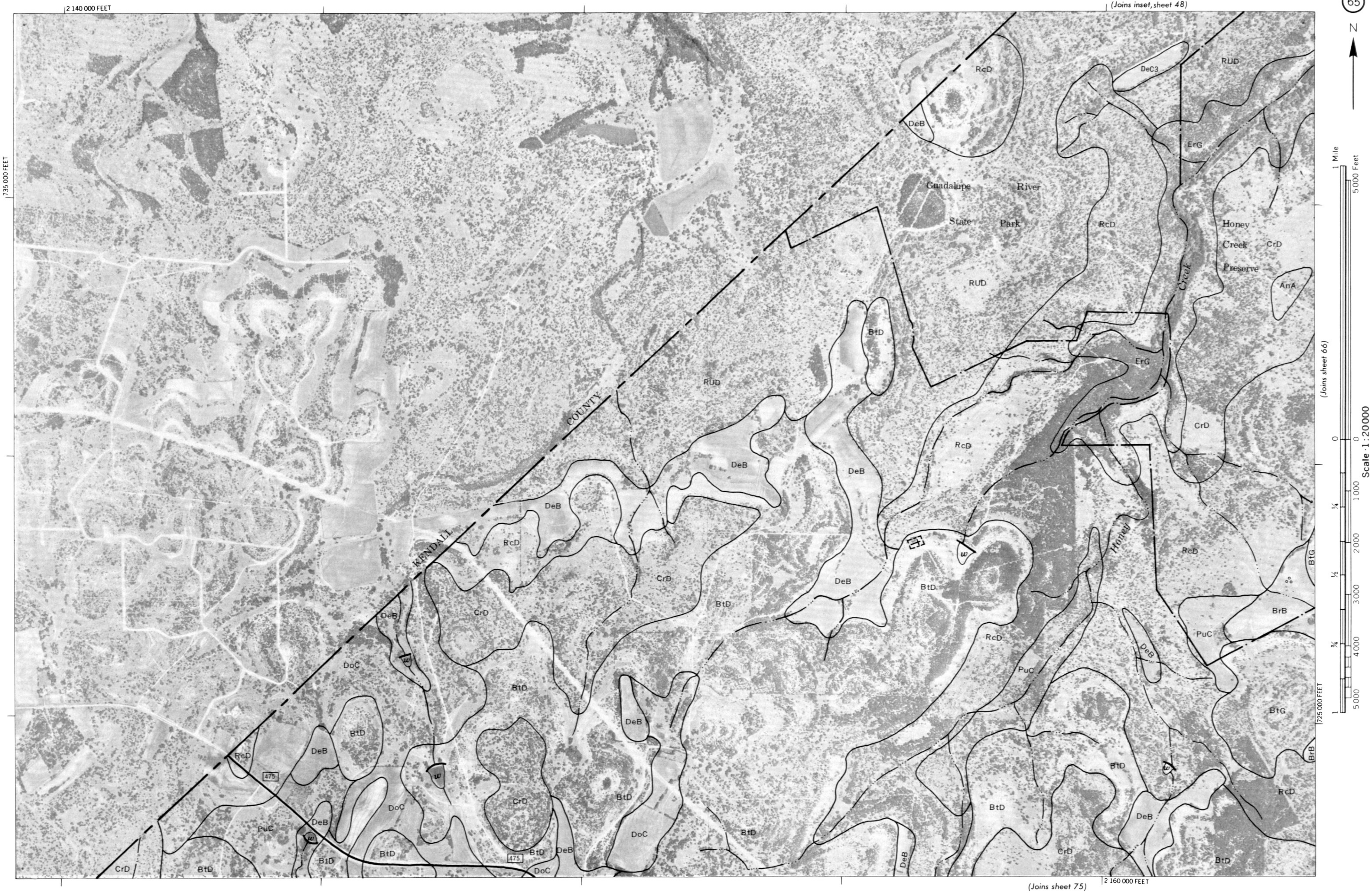

60
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
(Joins sheet 51)
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 69)
2 260 000 FEET
755 000 FEET
740 000 FEET
2 240 000 FEET
306
CANYON
LAKE
Jacobs
Creek
Baldy
Mountain
Canyon
City
GUADALUPE
RIVER
Horseshoe
Falls
Canoyn Lake Village West
FLOOD POOL LINE
BtD
BtG
BrB
CrD
KrA
KrB
PuC
SuA
BoB
Pt
ErG


61
N
(Joins sheet 52)
(Joins sheet 60)
(Joins sheet 62)
(Joins sheet 70)
2 265 000 FEET
2 285 000 FEET
755 000 FEET
740 000 FEET
HAYS COUNTY
COMAL COUNTY
PURGATORY ROAD
HOGG ROAD
GUADALUPE RIVER
Heiser Hollow
Cordova Hollow
306
BtG
BrB
BtD
CrD
AnB
RUD
SuA
Oa
BoB
DeB
PuC
RcD
ErG
1 Mile
5000 Feet
Scale 1:20000


62
N
(Joins sheet 53)
2 310 000 FEET
755 000 FEET
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 71)
2 290 000 FEET
740 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
RUD
CrD
AuB
ErG
w
Sink Creek
HUGO ROAD
Purgatory Creek
HAYS COUNTY
COMAL COUNTY


63
N
2 315 000 FEET
755 000 FEET
(Joins sheet 54)
(Joins sheet 64)
(Joins sheet 62)
(Joins sheet 72)
2 335 000 FEET
740 000 FEET
SAN MARCOS
(county seat)
Southwest Texas State College
Sink Creek
Purgatory Creek
Willow Springs Creek
MISSOURI KANSAS TEXAS RAILROAD
RAILROAD
1 Mile
5000 Feet
Scale 1:20000
RUD
CrD
MEC
MED
AnB
AnA
DeC3
DeB
TaB
KrB
KrC
PuC
DoC
ErG
GrC
HeB
LeB
LeA
Or
Tn
ByA
12
82
2439
35
81

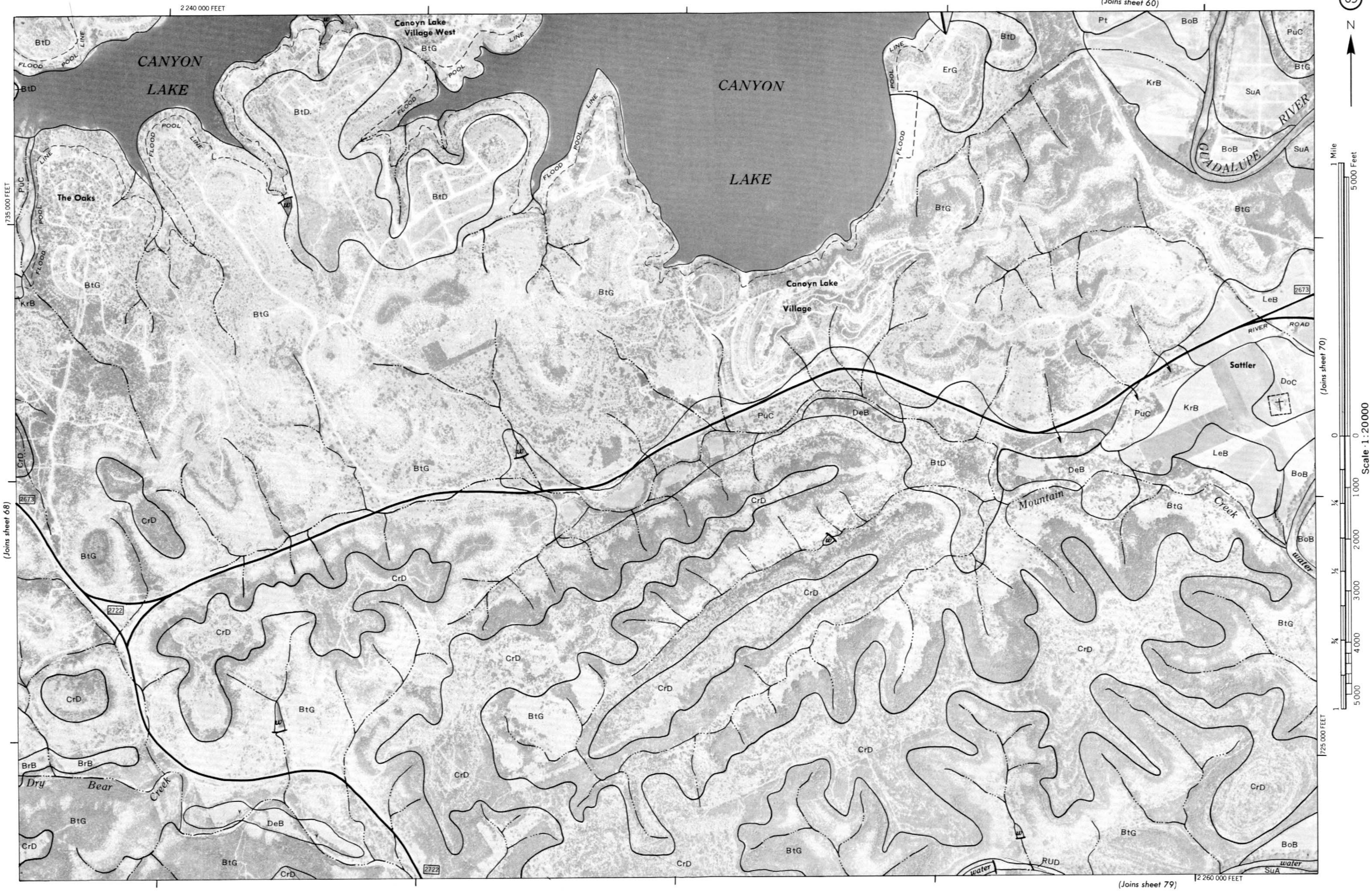

64
N
(Joins sheet 55)
(Joins sheet 63)
(Joins inset, sheet 56)
(Joins sheet 73)
2 360 000 FEET
755 000 FEET
740 000 FEET
2 340 000 FEET
1 Mile
5000 Feet
Scale 1:20000
SAN MARCOS
(county seat)
SPRING LAKE
Sink Creek
LIMEKILN ROAD
Purgatory Creek
Willow Springs
Creek
SAN MARCOS RIVER
Blanco River
River
MISSOURI PACIFIC RAILROAD
MISSOURI KANSAS TEXAS RAILROAD
CALDWELL COUNTY
Wood State Fish Hatchery
Sewage Disposal
water
35
81
82
12
80
21
123
621
RUD
AnA
KrA
LeB
MED
CrD
DeB
TaB
RUD
DoC
ErG
PuC
HeC3
KrB
GrC
Pt
Ok
Tn
ByA
ByB
HeB
LeA
SeB
Or
SeD
SuA
HoB
Oa


65
N
2 140 000 FEET
735 000 FEET
725 000 FEET
2 160 000 FEET
(Joins inset, sheet 48)
(Joins sheet 66)
(Joins sheet 75)
1 Mile
5000 Feet
0
¼
½
¾
1
1000
2000
3000
4000
5000
Scale 1:20000
KENDALL
COUNTY
Guadalupe
River
State
Park
Honey
Creek
Preserve
Honey
Creek
475
RcD
DeB
DeC3
RUD
ErG
CrD
AnA
BtD
RUD
DeB
CrD
DoC
PuC
BrB
BtG
BrB
w

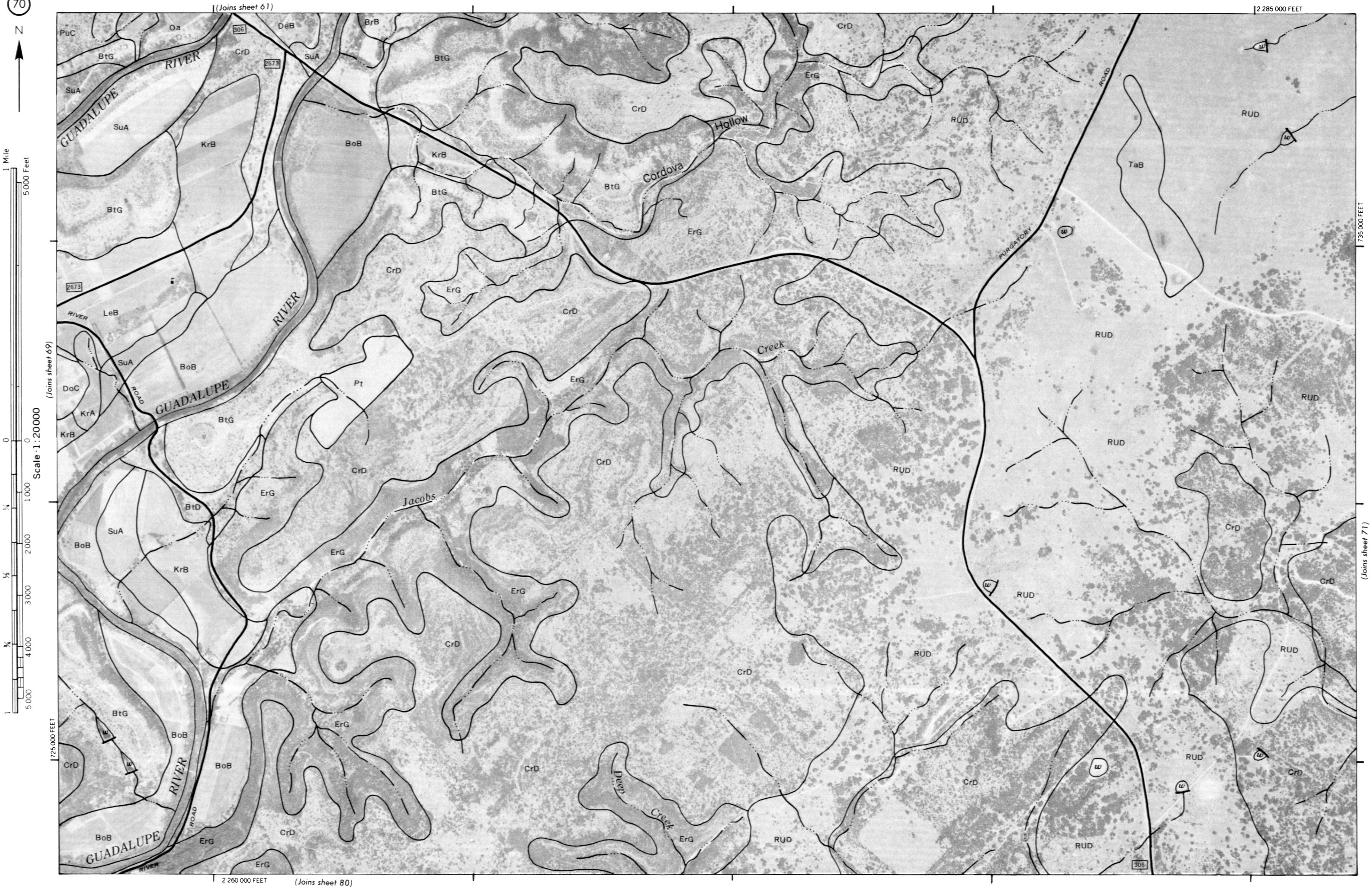

66
N
(Joins sheet 57)
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 76)
2 185 000 FEET
735 000 FEET
725 000 FEET
2 165 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Honey Creek
Honey Creek Preserve
GUADALUPE RIVER
Cypress Creek
Swine Creek
Creek
Ahern
Hanz
SPRING BRANCH ROAD
281
RUD
LeB
ErG
DeB
RcD
CrD
KrB
PuC
GrC
SeD
LeB
SeB
Ok
Or
BoB
AnB
TaB
AnA
Pt
DeC3
BtD
BrB
BtG
PuC
SuB
CrD
RcD
DeB
BtD
BtG
BrB
LeB
KrB
AnA


(Joins sheet 58)
(Joins sheet 66)
(Joins sheet 68)
(Joins sheet 77)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
735 000 FEET
725 000 FEET
2 210 000 FEET
GUADALUPE
RIVER
Cypress Creek
Hanz Creek
Elm Creek
Miller Creek
Jentsch Creek
Tom Creek
Creek
311
PuC
CrD
SeB
LeB
BoB
Ok
SuB
SeD
SuA
Pt
BtD
RcD
BtG
BrB
DoC
KrB
KrC
KrA
TaB
DeB
ErG
w


68
N
(Joins sheet 59)
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 78)
2 235 000 FEET
735 000 FEET
725 000 FEET
2 215 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Canyon Lake Mobil Home Estates
Canyon Lake Forest
Startzville
Startz Hill
Jentsch
Creek
Tom
Dry
Bear
water
FLOOD POOL LINE
2673
3159
BtG
BrB
RcD
CrD
ErG
BtD
PuC
DeB
SuB
KrB
DoC
w


2 240 000 FEET
(Joins sheet 60)
N
CANYON LAKE
CANYON
LAKE
Canoyn Lake Village West
The Oaks
Canoyn Lake Village
Sattler
GUADALUPE RIVER
RIVER ROAD
Mountain Creek
Dry Bear Creek
FLOOD POOL LINE
735 000 FEET
(Joins sheet 68)
(Joins sheet 70)
725 000 FEET
2 260 000 FEET
(Joins sheet 79)
2673
2722
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1000
2000
3000
4000
5000
BtD
BtG
ErG
Pt
BoB
PuC
KrB
SuA
LeB
DoC
DeB
CrD
BrB
RUD
w
water

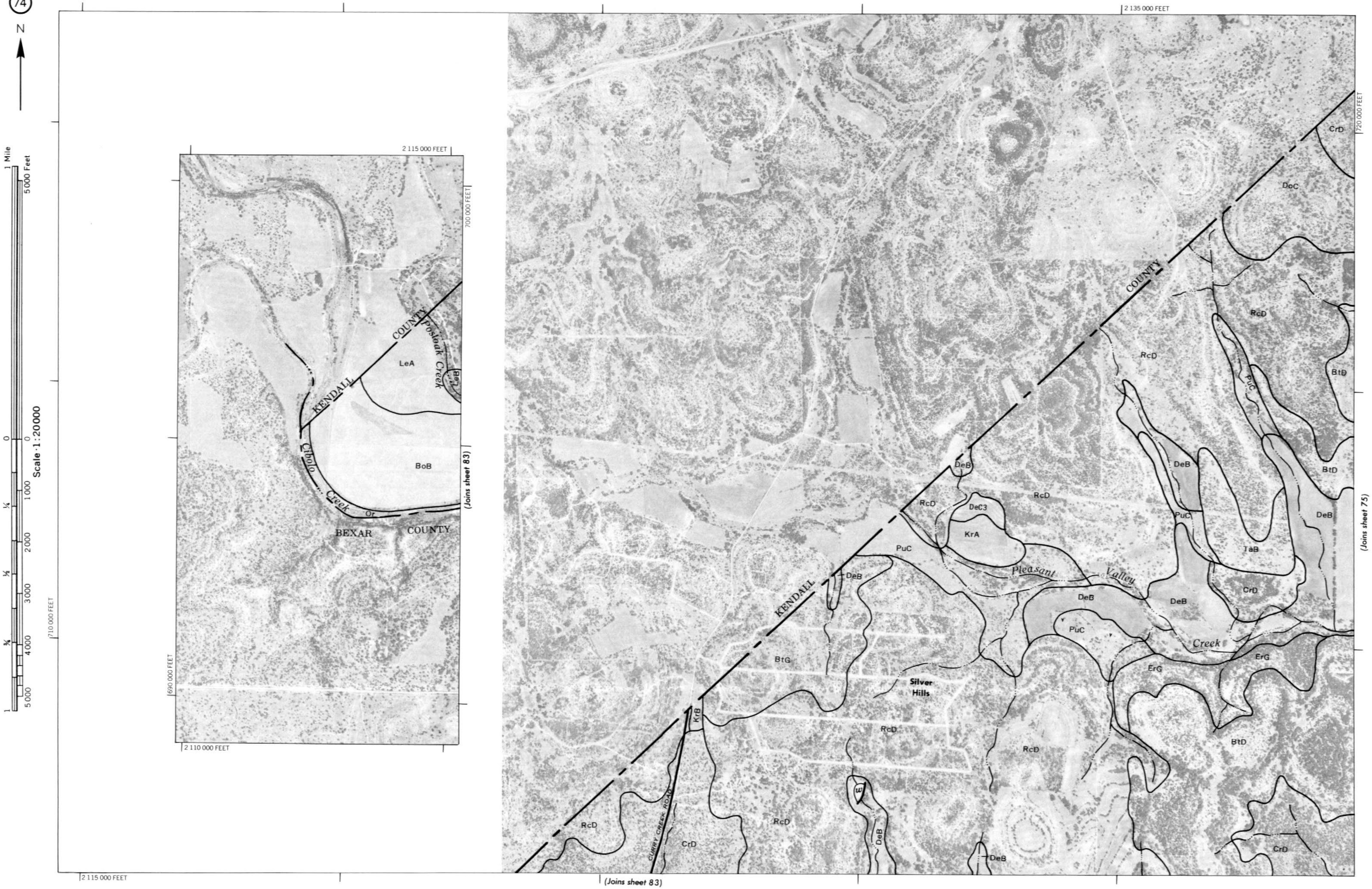
COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 70




71
N
(Joins sheet 62)
(Joins sheet 70)
(Joins sheet 72)
(Joins sheet 81)
2 290 000 FEET
735 000 FEET
725 000 FEET
2 310 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
HAYS
COMAL
COUNTY
COUNTY
Bullhead
Hollow
Coal Kiln
Hill
FLOOD POOL LINE
RUD
CrD
Pt
ErG
MED
BtD
SuB
DeB


(Joins sheet 63)
(Joins sheet 71)
(Joins sheet 73)
(Joins sheet 82)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
2 335 000 FEET
735 000 FEET
725 000 FEET
2 315 000 FEET
SAN MARCOS
(county seat)
Robert Lowman
Airfield
Trunk Hill
Willow
Springs
Creek
Cottonwood
Creek
McCARTY
LANE
REDWOOD
ROAD
MISSOURI
KANSAS
TEXAS
PACIFIC
RAILROAD
2439
35
81
123
RUD
CrD
DeB
KrB
MEC
BrB
BtD
MED
PuC
SuB
Pt
AnB
AnA
ByA
HoB
HeB
HeC3
HeD3
HvD
Tn
DeC3
AgC3
AgD3
HeD3


73
N
(Joins sheet 64)
(Joins sheet 72)
(Joins inset)
2 340 000 FEET
735 000 FEET
725 000 FEET
2 360 000 FEET
Wood State Fish Hatchery
water
SAN MARCOS
(county seat)
Blanco River
SAN MARCOS RIVER
CALDWELL COUNTY
GUADALUPE COUNTY
REDWOOD ROAD
Cottonwood Creek
ByA
HoB
HeC3
HeD3
Oa
Or
Pt
LeB
Ok
SuA
LeA
KrA
HgD
GrC
ByB
SeD
HvD
HvB
FeF4
AgD3
AgC3
Tn
HeB
123
621
(Joins lower left)
2 336 000 FEET
723 000 FEET
718 000 FEET
2 341 000 FEET
(Joins sheet 82)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000


74
N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5 000
2 115 000 FEET
2 110 000 FEET
700 000 FEET
690 000 FEET
710 000 FEET
2 135 000 FEET
720 000 FEET
(Joins sheet 83)
(Joins sheet 75)
KENDALL
COUNTY
BEXAR
Cibolo
Creek
Postoak Creek
LeA
BoB
Or
Pleasant
Valley
Creek
Silver Hills
CURRY CREEK ROAD
CrD
DoC
RcD
BtD
PuC
DeB
DeC3
KrA
TaB
ErG
BtG
KrB

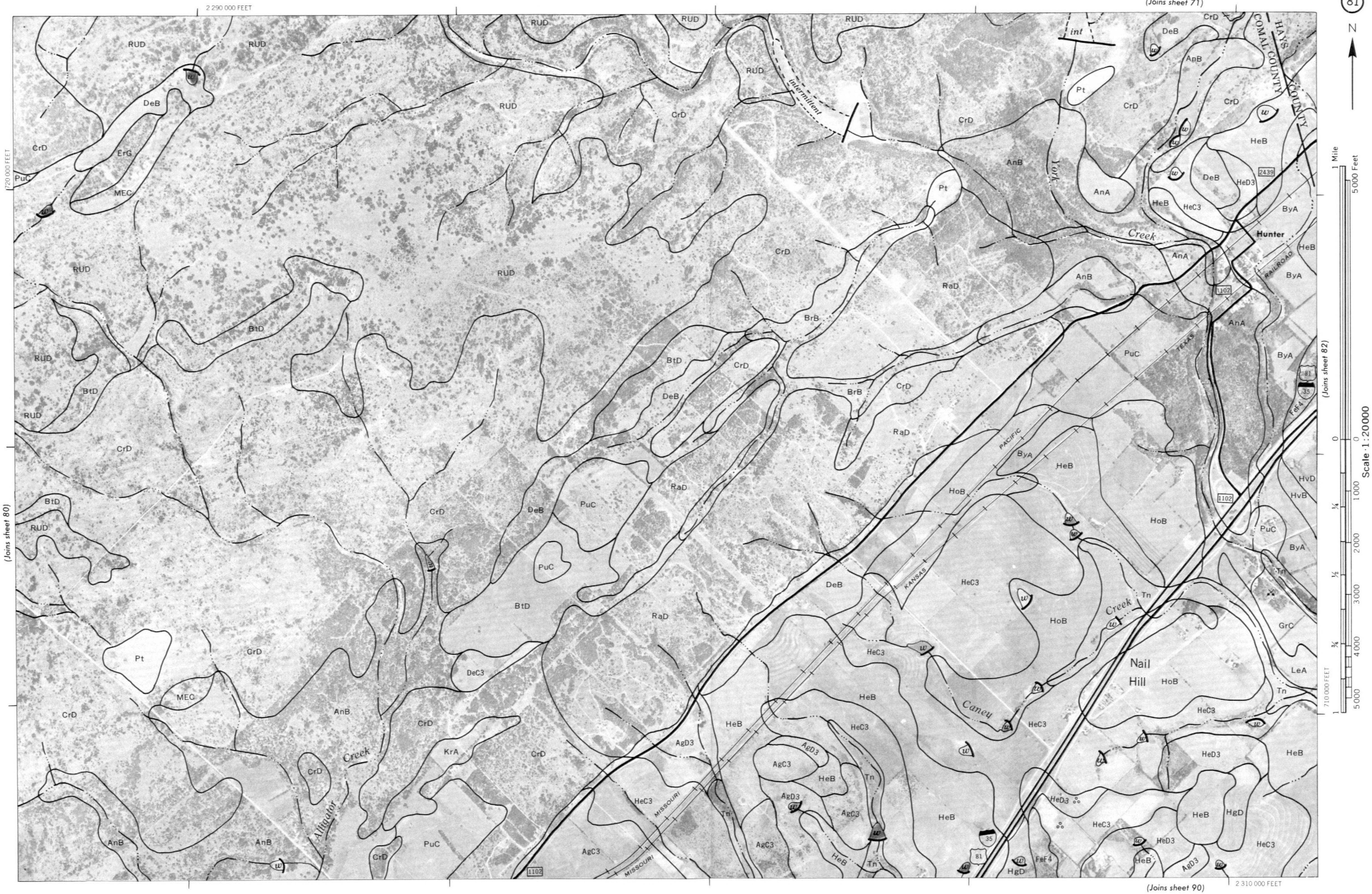

(Joins sheet 65)
(Joins sheet 76)
(Joins sheet 74)
(Joins sheet 84)
2 140 000 FEET
720 000 FEET
710 000 FEET
2 160 000 FEET
N
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
Scale 1:20000
KENDALL COUNTY
475
Honey Creek
Oak Cliff Acres
Pleasant Valley Creek
Kelly Creek
w
BtD
PuC
DeB
DoC
CrD
RcD
AnB
SuB
BtG
DeC3
AnA
KrB
RUD
BrB
PuC
DeB
BtD
CrD

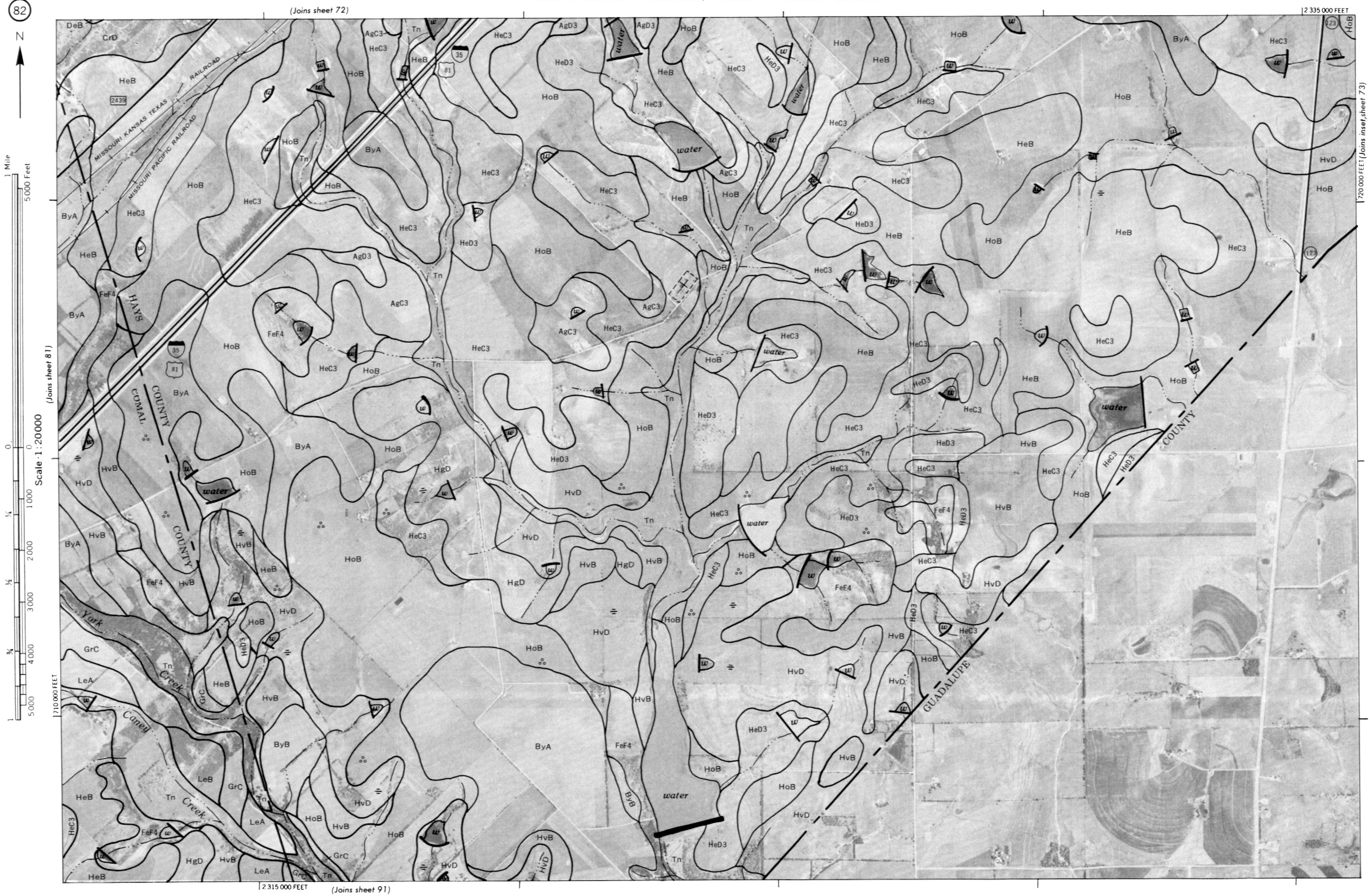

76
N
(Joins sheet 66)
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 85)
2 185 000 FEET
2 165 000 FEET
720 000 FEET
710 000 FEET
1 Mile
5000 Feet
Scale 1:20000
Devils Hill
Swine Creek
Lewis Creek
Indian Creek
SPRING BRANCH ROAD
BULVERDE ROAD
water
475
46
281
BtD
BtG
RcD
CrD
BrB
LeB
PuC
SuB
DeB
KrB
Pt
LeA
ErG

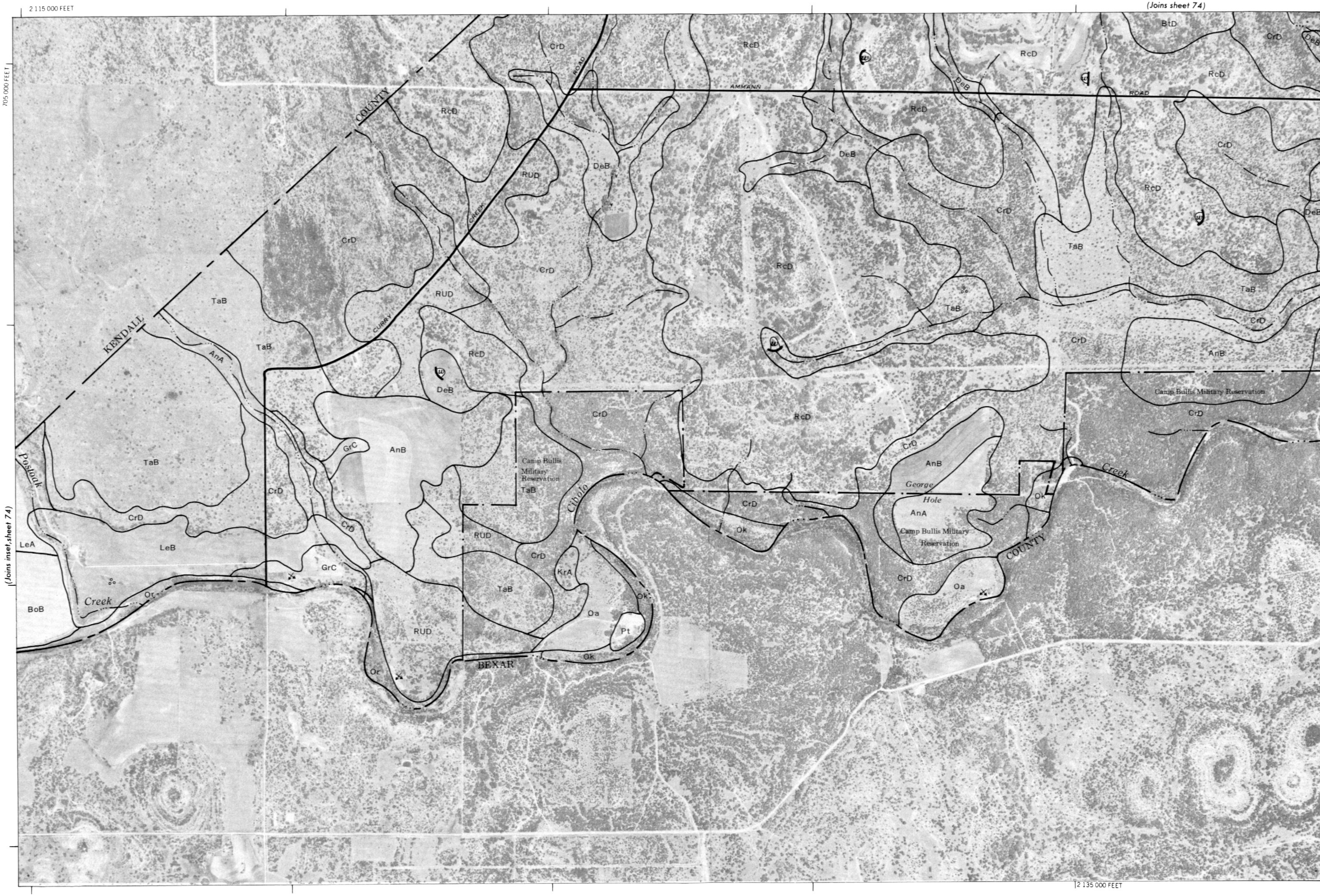

77
2 190 000 FEET
720 000 FEET
(Joins sheet 67)
(Joins sheet 76)
(Joins sheet 78)
(Joins sheet 86)
710 000 FEET
2 210 000 FEET
N
Smithson Valley
Elm Creek
Lewis Creek
Dripping Springs Creek
West Fork
SMITHSON VALLEY ROAD
311
3159
46
1 Mile
5000 Feet
Scale 1:20000
BtG
BtD
BrB
ErG
CrD
PuC
DeB
RaD
SuB
KrB
DeC3


79
N
2 240 000 FEET
(Joins sheet 69)
720 000 FEET
(Joins sheet 78)
(Joins sheet 80)
(Joins sheet 88)
2 260 000 FEET
710 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Dry Bear
Creek
Bear
Creek
Tausch
Creek
Turkey
Creek
Little
Bear
Elm
Creek
GUADALUPE
RIVER
RIVER ROAD
water
2722
BtG
CrD
SuB
ErG
RUD
AnB
SuA
Or
DeB
BoB

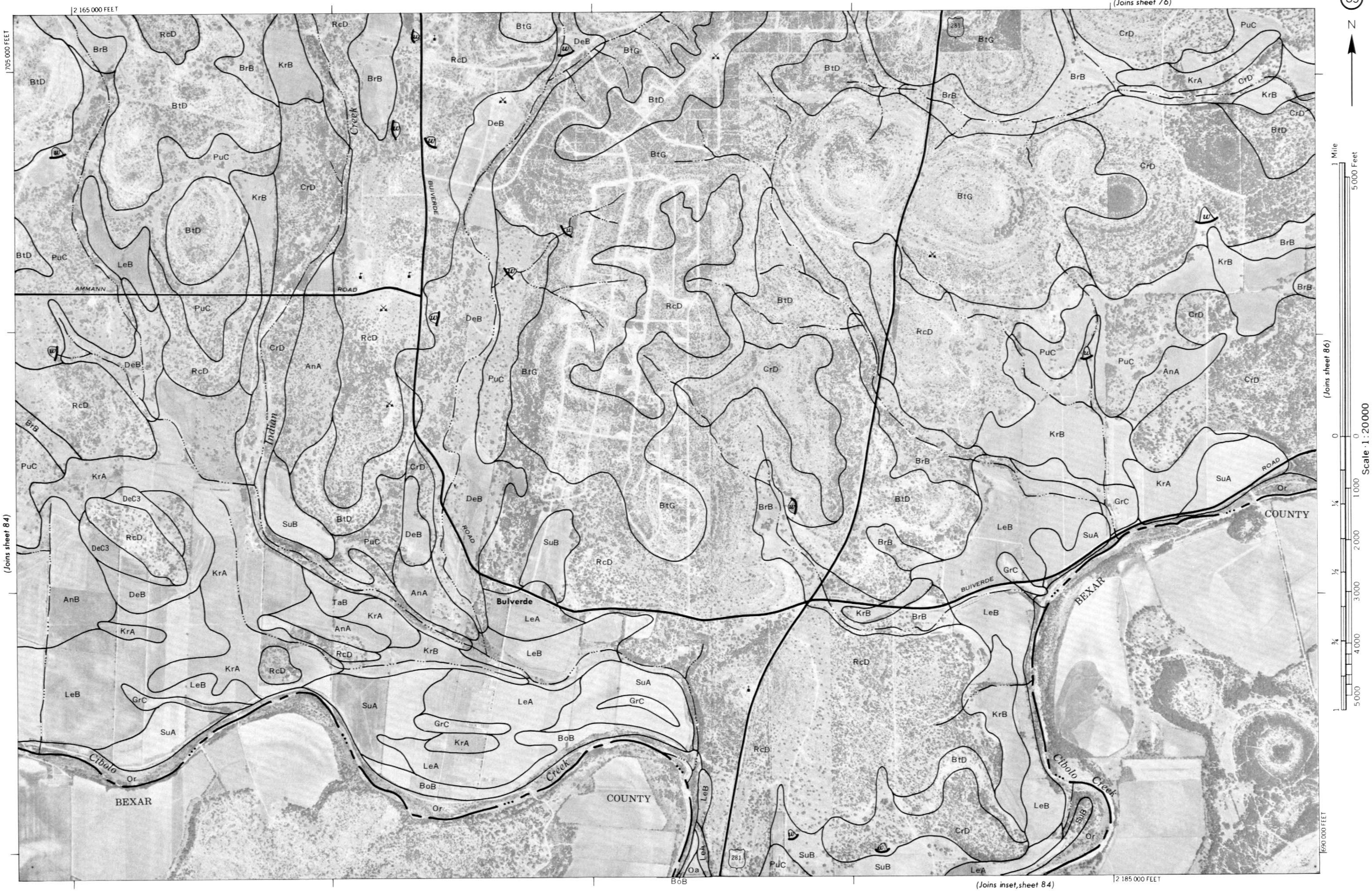

80
N
(Joins sheet 70)
(Joins sheet 79)
(Joins sheet 81)
(Joins sheet 89)
2 285 000 FEET
720 000 FEET
710 000 FEET
2 265 000 FEET
Scale 1:20000
1 Mile
5000 Feet
GUADALUPE RIVER
RIVER ROAD
Deep Creek
Isaac Creek
water
306
CrD
ErG
BoB
RUD
MEC
PuC
TaB
BtD
SuA
DeB
int


81
N
2 290 000 FEET
(Joins sheet 71)
720 000 FEET
(Joins sheet 80)
(Joins sheet 82)
710 000 FEET
(Joins sheet 90)
2 310 000 FEET
1 Mile
5000 Feet
Scale 1:20000
HAYS COUNTY
COMAL COUNTY
Hunter
Nail Hill
York Creek
Alligator Creek
Caney Creek
intermittent
int
MISSOURI KANSAS TEXAS PACIFIC RAILROAD
2439
1102
81
35
RUD
CrD
DeB
ErG
MEC
PuC
BtD
Pt
AnB
AnA
KrA
DeC3
RaD
BrB
HeB
HeC3
HeD3
HoB
ByA
HvD
HvB
GrC
LeA
Tn
FeF4
AgD3
AgC3
HgD
w


82
N
(Joins sheet 72)
(Joins sheet 81)
(Joins inset, sheet 73)
(Joins sheet 91)
2 335 000 FEET
720 000 FEET
710 000 FEET
2 315 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
MISSOURI KANSAS TEXAS RAILROAD
MISSOURI PACIFIC RAILROAD
HAYS
COMAL COUNTY
COUNTY
GUADALUPE
COUNTY
York Creek
Caney Creek
35
81
2439
123
water
DeB
CrD
HeB
HoB
ByA
HeC3
HeD3
AgC3
AgD3
Tn
FeF4
HvB
HvD
HgD
GrC
LeA
LeB
ByB
w


2 115 000 FEET
(Joins sheet 74)
705 000 FEET
(Joins inset, sheet 74)
(Joins sheet 84)
690 000 FEET
2 135 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
AMMANN ROAD
CURRY CREEK ROAD
KENDALL COUNTY
BEXAR COUNTY
Postoak Creek
Cibolo Creek
George Hole
Camp Bullis Military Reservation
CrD
RcD
DeB
RUD
TaB
AnA
AnB
GrC
LeA
LeB
BoB
Or
Ok
Oa
Pt
KrA
BtD


(Joins sheet 75)
(Joins sheet 83)
(Joins sheet 85)
(Joins sheet 85)
N
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
2 160 000 FEET
705 000 FEET
2 140 000 FEET
2 182 000 FEET
2 177 000 FEET
689 000 FEET
685 000 FEET
690 000 FEET
AMMANN ROAD
Camp Bullis Military Reservation
Canyon View Acres
Pleasant Valley Creek
Kelly Creek
Cibolo Creek
BEXAR COUNTY
281
BtD
DeB
CrD
SuB
AnB
RcD
RUD
TaB
LeB
PuC
DeC3
AnA
KrB
BoB
Or
Oa
LeA
SuA
BrB
KrA
DoC


(Joins sheet 76)
(Joins sheet 86)
(Joins sheet 84)
(Joins inset, sheet 84)
2 165 000 FEET
2 185 000 FEET
705 000 FEET
690 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000
AMMANN
ROAD
BULVERDE
ROAD
Bulverde
BUIVERDE
ROAD
Indian
Creek
Cibolo
Creek
BEXAR
COUNTY
281
BrB
BtD
RcD
KrB
CrD
PuC
LeB
DeB
BtG
KrA
DeC3
AnA
AnB
SuB
SuA
TaB
LeA
GrC
BoB
Or
Oa
LeA
BoB

N

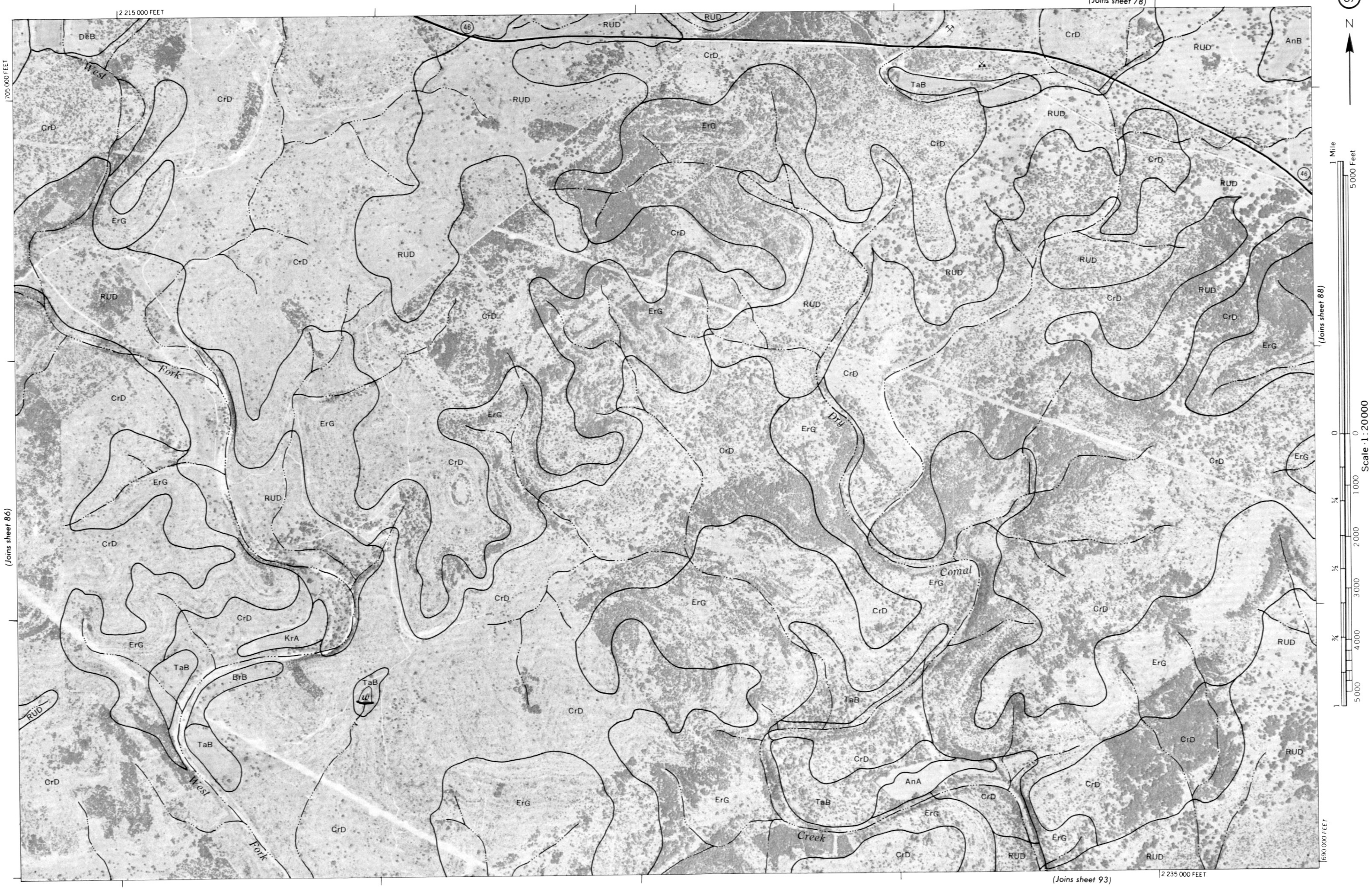
Scale 1:20 000

1 Mile

5 000 Feet

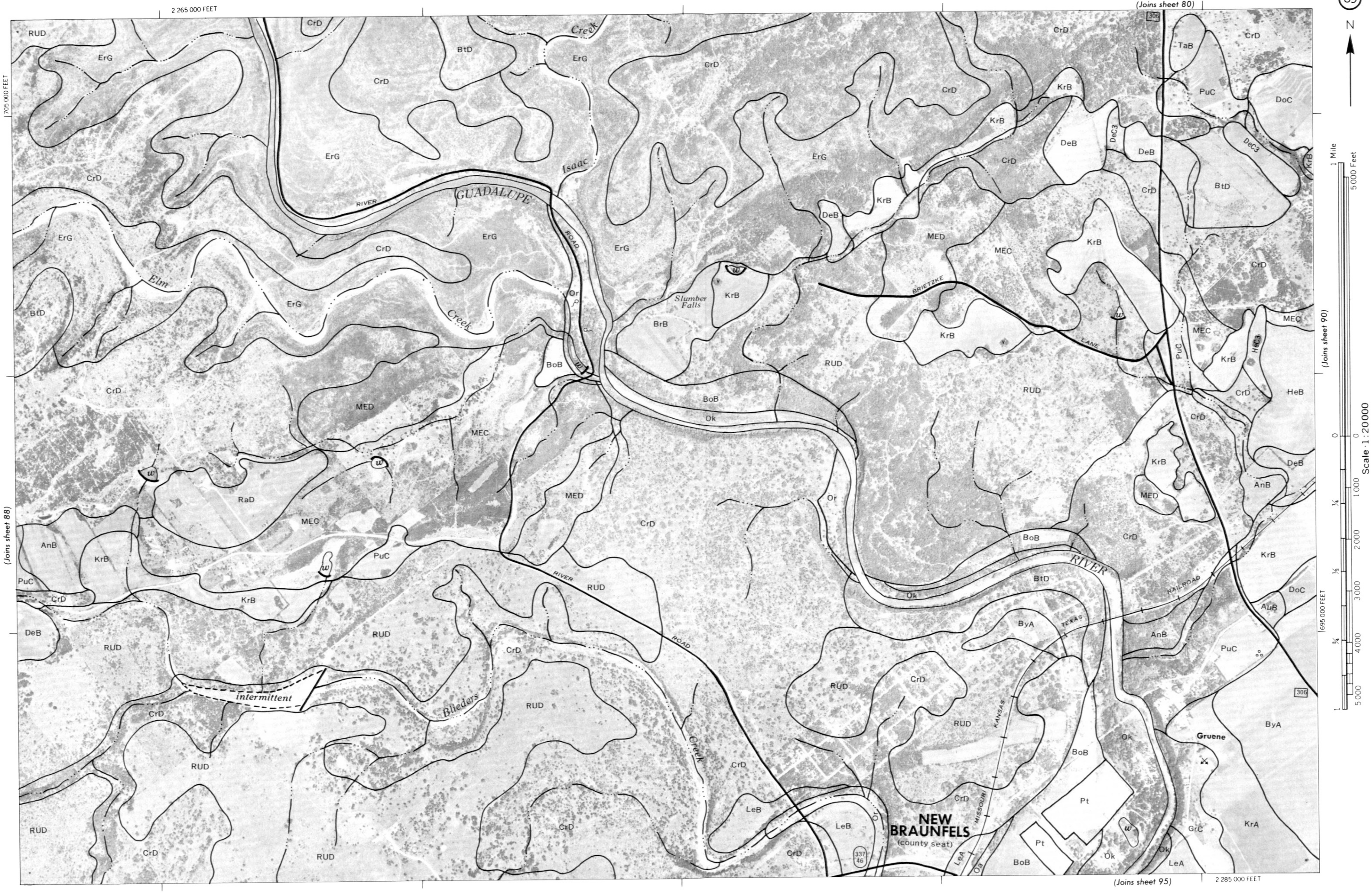
0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000


2 215 000 FEET
705 000 FEET
(Joins sheet 78)
(Joins sheet 86)
(Joins sheet 88)
(Joins sheet 93)
690 000 FEET
2 235 000 FEET
N
West
Fork
Dry
Comal
Creek
46
DeB
CrD
RUD
ErG
TaB
AnB
KrA
BrB
AnA
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


88
N
(Joins sheet 79)
(Joins sheet 87)
(Joins sheet 89)
(Joins sheet 94)
2 260 000 FEET
705 000 FEET
690 000 FEET
2 240 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Elm
Creek
Bleeders Creek
Mission Valley
RUD
CrD
ErG
AnB
BtD
Pt
TaB
MEC
KrB
LeB
RaD
PuC
AnA
DeB
MED
DeC3
KrC
w
46
2722


N
(Joins sheet 68)
(Joins sheet 77)
(Joins sheet 79)
(Joins sheet 87)
2 235 000 FEET
720 000 FEET
710 000 FEET
2 215 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
3159
46
Bear Creek
Dry
Bear
Creek
Dry
Comal
Creek
West
Fork
water
BtG
CrD
TaB
Pt
RUD
ErG
DeB
BtD
PuC
DeC3
DoC
KrB
AnB
SuB
BrB
BtG
RUD
AuB
BtD
DeB


(Joins sheet 80)
(Joins sheet 88)
(Joins sheet 90)
(Joins sheet 95)
2 265 000 FEET
2 285 000 FEET
705 000 FEET
695 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
GUADALUPE
RIVER
Isaac
Creek
Elm
Creek
Bleders
Creek
intermittent
Slumber Falls
ROAD
BRIETZKE
LANE
TEXAS
RAILROAD
KANSAS
MISSOURI
NEW BRAUNFELS
(county seat)
Gruene
306
337
46
RUD
ErG
CrD
BtD
MED
MEC
RaD
AnB
KrB
PuC
DeB
BoB
BrB
Ok
Or
ByA
LeB
LeA
Pt
GrC
KrA
TaB
DoC
DeC3
HeB
HeC3
AuB

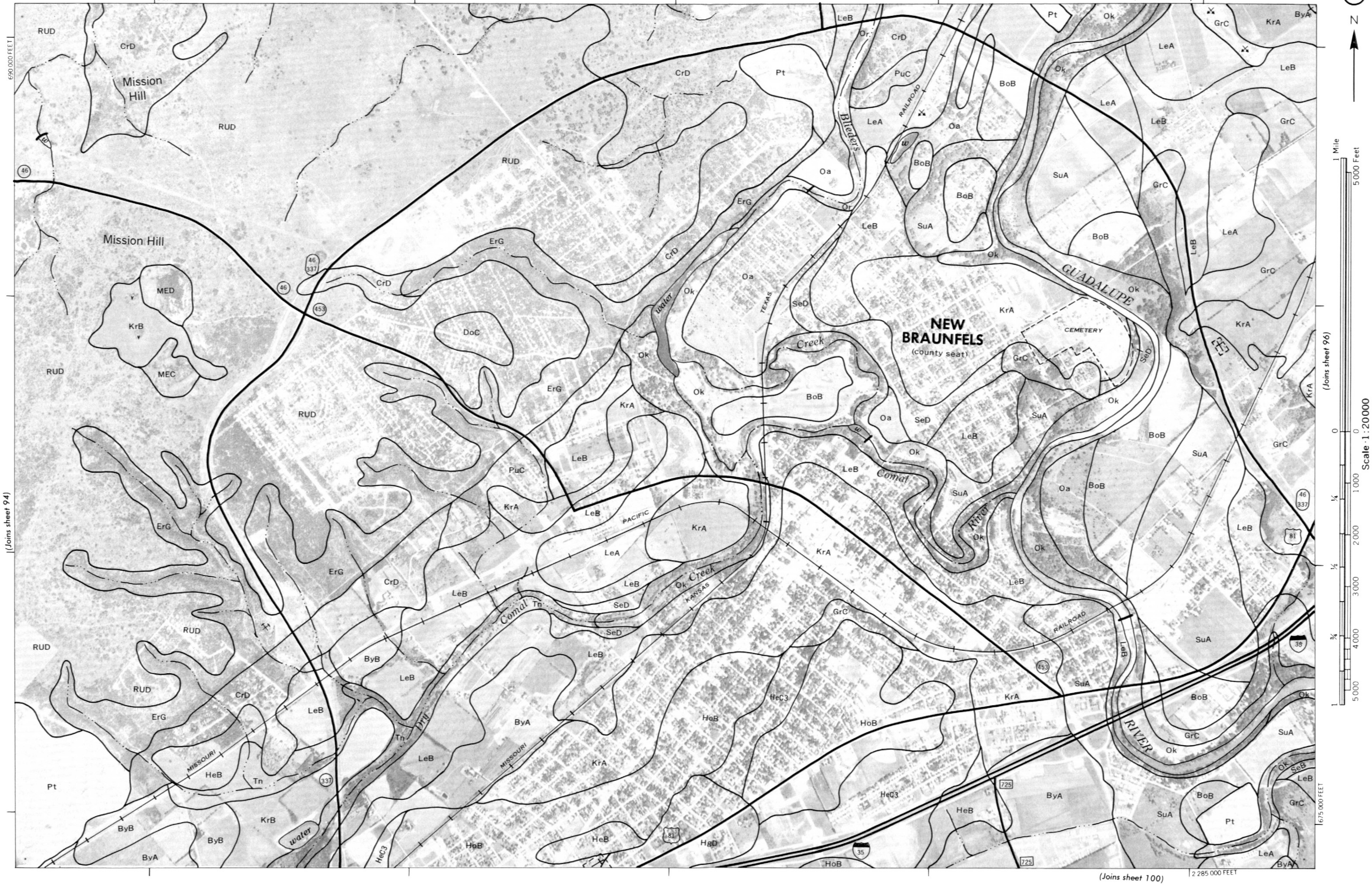

N
(Joins sheet 81)
(Joins sheet 89)
(Joins sheet 91)
(Joins sheet 96)
1 Mile
5000 Feet
Scale 1:20 000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
2 310 000 FEET
705 000 FEET
695 000 FEET
2 290 000 FEET
MISSOURI
KANSAS
TEXAS
PACIFIC
RAILROAD
Haley Tank
Alligator
Creek
Water
Hole
Creek
Mesquite
Creek
WATSON
LANE
GUADALUPE
COUNTY
water
35
81
1102
1101
306
CrD
AnB
RUD
DoC
KrB
DeC3
PuC
MED
RaD
CrD
MEC
DeB
ByA
HoB
HvB
KrA
HeB
HeD3
HgD
ByB
Tn
HeC3
AgC3
AgD3
FeF4
HvD
Pt
KrA


2 315 000 FEET
705 000 FEET
695 000 FEET
2 335 000 FEET
(Joins sheet 90)
N
1 Mile
5 000 Feet
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
Scale 1:20000
COMAL
HAYS
COUNTY
COUNTY
GUADALUPE
COUNTY
Bading
Hill
Water
Hote
Creek
York
Creek
water
1101
1101
FeF4
HeB
HgD
HvB
LeA
GrC
Tn
HoB
ByA
HvD
HeD3
LeB
HeC3
HvB
ByB
HeB
AgC3
AgD3
HgD
LeA
FeF4
HvD
HeC3
Tn

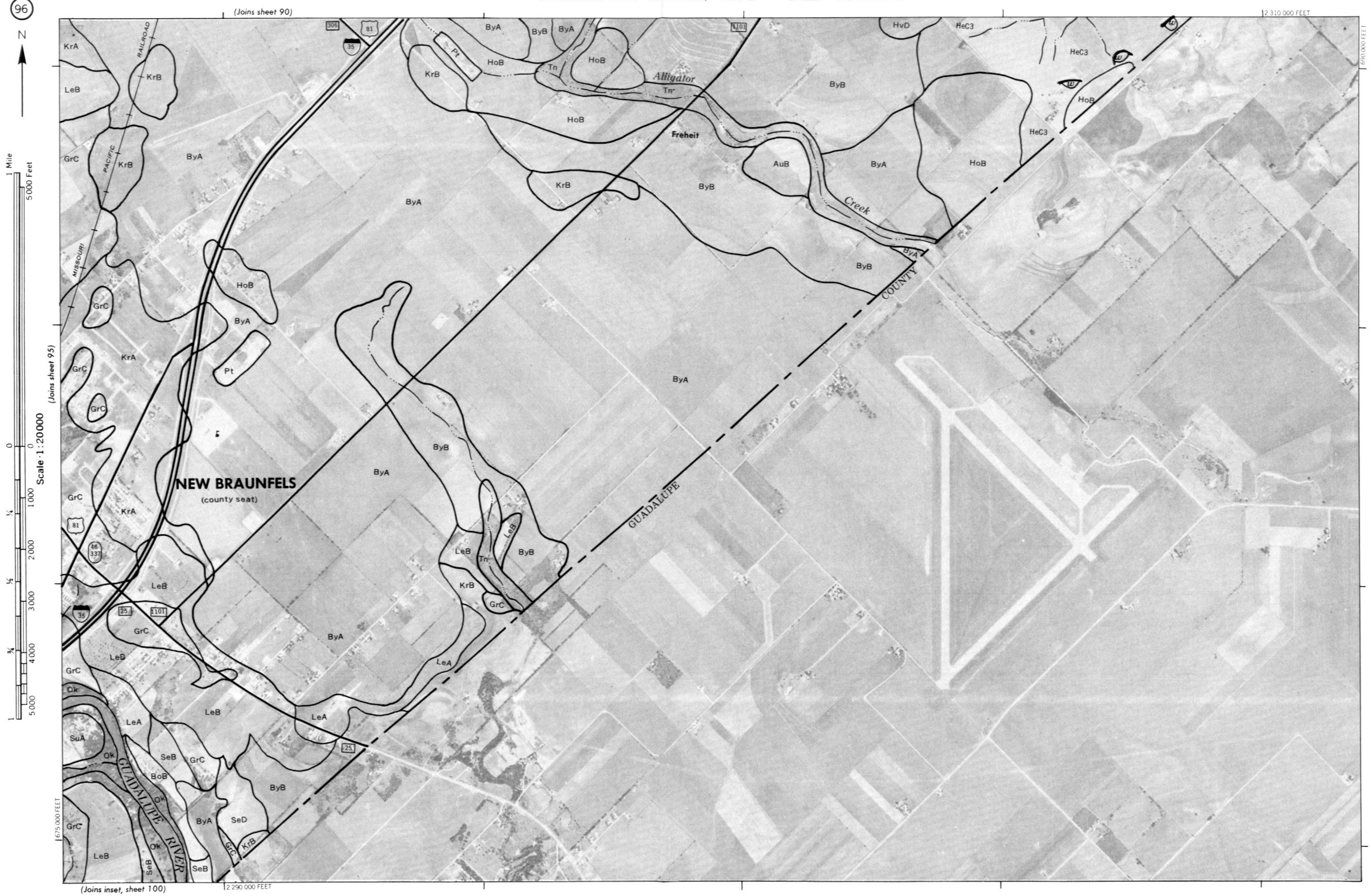

N
(Joins sheet 86)
(Joins sheet 99)
(Joins sheet 102)
(Joins sheet 93)
(Joins sheet 97)
Scale 1:20000
1 Mile
5000 Feet
2 210 000 FEET
2 255 000 FEET
655 000 FEET
650 000 FEET
2 240 000 FEET
675 000 FEET
2 190 000 FEET
Cibolo Creek
BEXAR COUNTY
GUADALUPE COUNTY
MISSOURI KANSAS TEXAS RAILROAD
BtG
KrB
GrC
ErG
Or
LeB
GrC
SuA
BoB
SuB
RUD
CrD
HgD
HoB
HeB
ByB
ByA
AgC3
AgD3
HeC3
HeD3
HvD
CaC3
RaD
Tn
AuC3
AuB
Oa

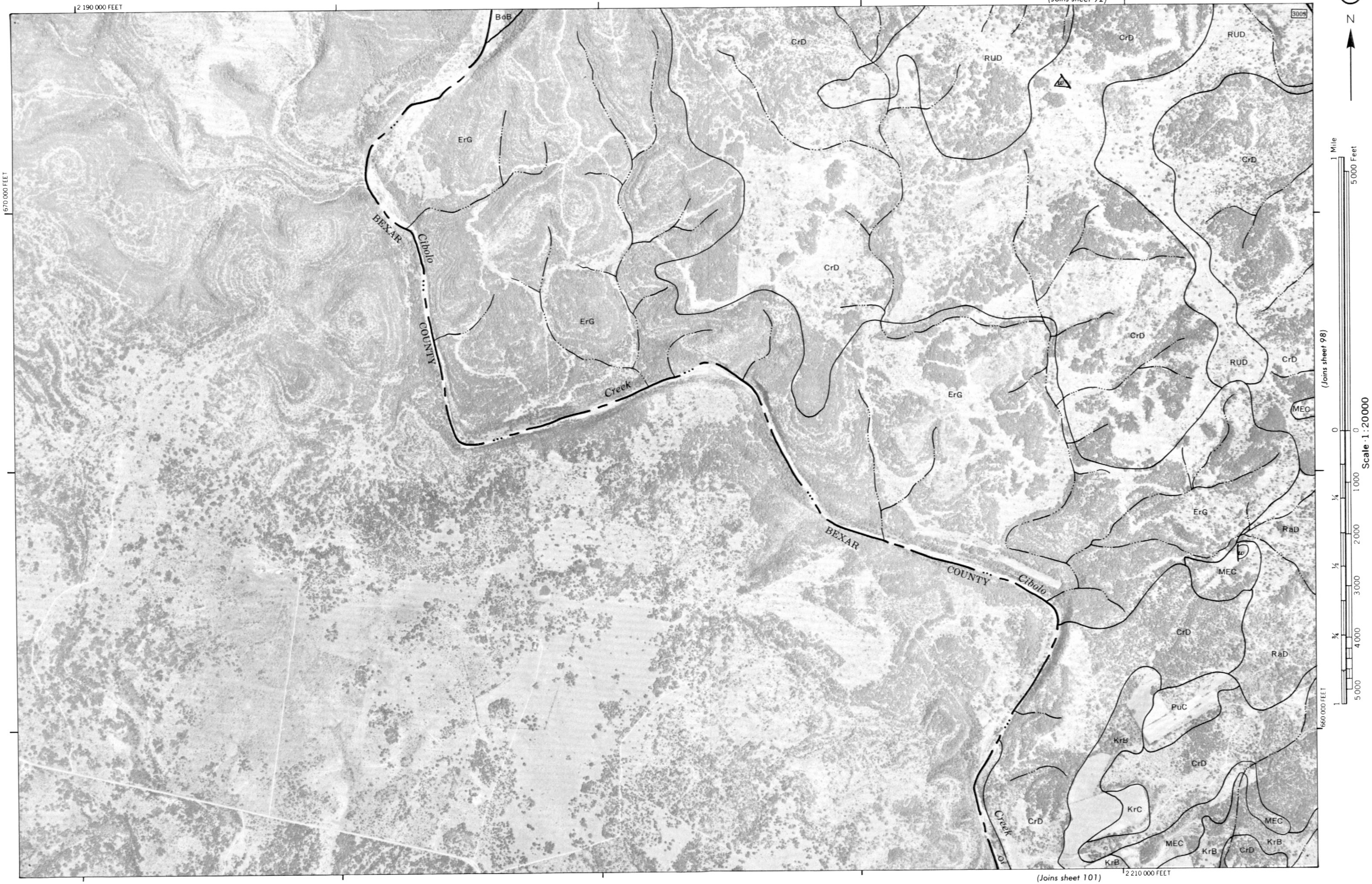

2 215 000 FEET
690 000 FEET
(Joins sheet 87)
(Joins sheet 92)
(Joins sheet 94)
(Joins sheet 98)
2 235 000 FEET
675 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
West
Fork
Creek
Dry
Comal
Creek
Comal
Creek
Dry
intermittent
SCHOENTHAL
ROAD
1863
3009
CrD
ErG
DeB
RUD
TaB
KrA
BtD
KrB
MEC
AnB
Pt
RaD
DeC3
water
int
w


(Joins sheet 88)
(Joins sheet 93)
(Joins sheet 95)
(Joins sheet 99)
2 260 000 FEET
690 000 FEET
675 000 FEET
2 240 000 FEET
N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
1863
46
Blieders
Creek
Comal
Creek
Dry
KRUEGAR
LANE
water
RUD
CrD
RaD
DoC
BtD
KrB
KrC
ErG
MEC
MED
DeC3
DeB
PuC
BrB
TaB
AnA
AnB
Pt



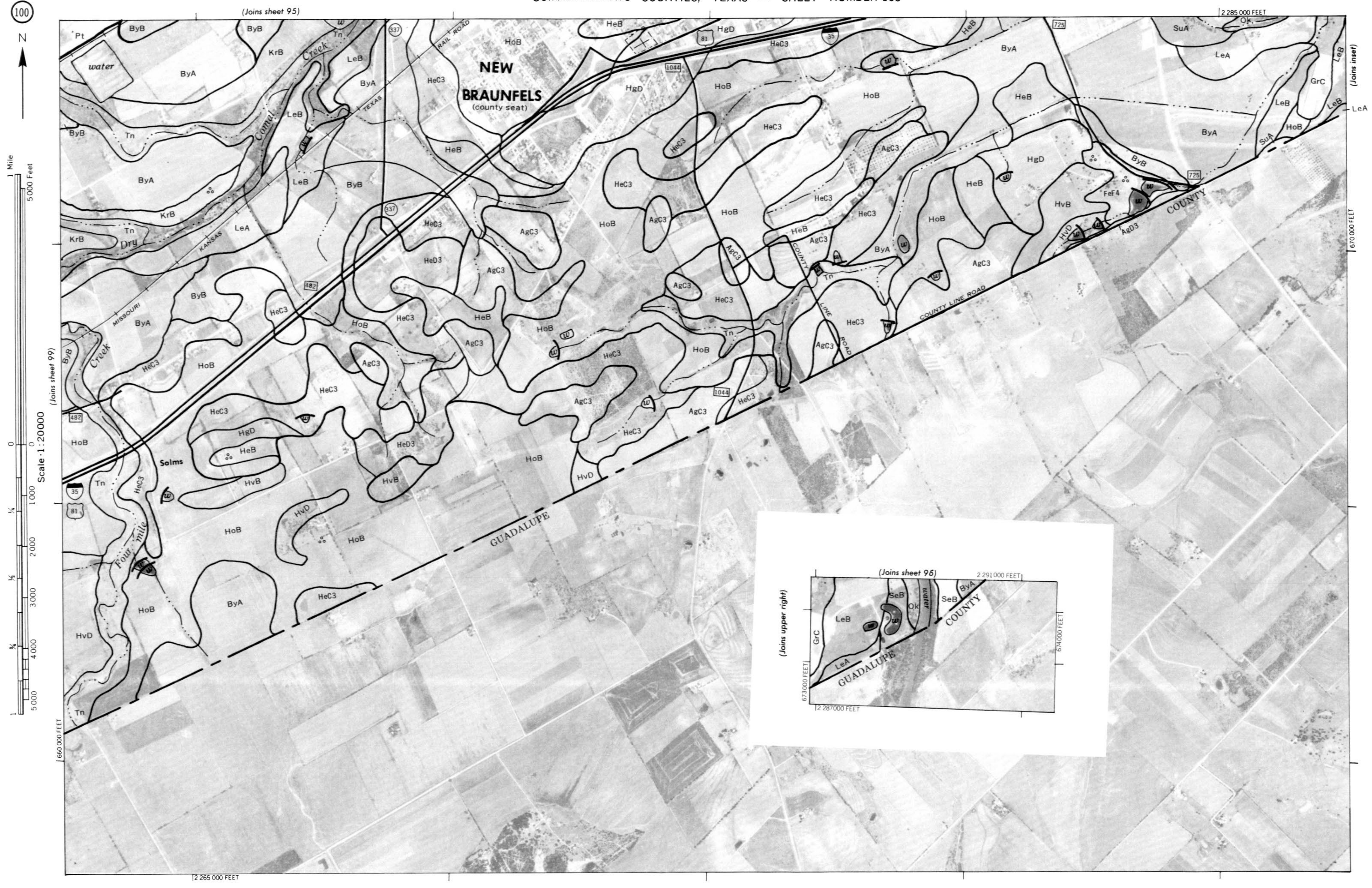
95
(Joins sheet 89)
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 100)
2 265 000 FEET
2 285 000 FEET
690 000 FEET
675 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
NEW BRAUNFELS
(county seat)
Mission Hill
CEMETERY
GUADALUPE
RIVER
Comal
Creek
Bleeders
Dry
water
TEXAS
PACIFIC
MISSOURI
KANSAS
RAILROAD


96
N
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
0
1000
2000
3000
4000
5000
(Joins sheet 90)
(Joins sheet 95)
(Joins inset, sheet 100)
2 310 000 FEET
2 290 000 FEET
690 000 FEET
675 000 FEET
NEW BRAUNFELS
(county seat)
Freheit
Alligator
Creek
GUADALUPE
COUNTY
GUADALUPE
RIVER
RAILROAD
PACIFIC
MISSOURI
306
81
35
1101
46
337
25
KrA
LeB
KrB
GrC
ByA
ByB
HoB
Pt
Tn
HvD
HeC3
AuB
LeA
SeB
SeD
BoB
Ok
SuA


97
2 190 000 FEET
(Joins sheet 92)
3005
N
670 000 FEET
BoB
CrD
RUD
CrD
RUD
ErG
CrD
BEXAR
Cibolo
COUNTY
ErG
Creek
CrD
CrD
RUD
CrD
ErG
MEC
ErG
RaD
BEXAR
COUNTY
Cibolo
MEC
CrD
RaD
PuC
KrB
CrD
KrC
MEC
Creek
CrD
MEC
KrB
CrD
KrB
KrB
(Joins sheet 98)
1 Mile
5000 Feet
0
0
1000
¼
2000
½
3000
¾
4000
1
5000
Scale 1:20000
660 000 FEET
2 210 000 FEET
(Joins sheet 101)


98
N
(Joins sheet 93)
(Joins sheet 97)
(Joins sheet 99)
(Joins sheet 102)
1 Mile
5 000 Feet
Scale 1:20000
2 235 000 FEET
670 000 FEET
660 000 FEET
2 215 000 FEET
Bear
Creek
West Fork
Dry
Comal
Creek
inter-mittent
SCHOENTHAL ROAD
water
Air Strip
Garden Ridge
RUD
CrD
MEC
KrB
KrC
TaB
DeB
RaD
DoC
ErG
PuC
MED
Or
Pt
HeB
HoB
HeC3
Tn


2 240 000 FEET
(Joins sheet 94)
N
670 000 FEET
(Joins sheet 98)
(Joins sheet 100)
660 000 FEET
(Joins inset, sheet 92)
2 260 000 FEET
1 Mile
5000 Feet
0
¼
½
¾
1
1000
2000
3000
4000
5000
Scale 1:20000
Dry Comal Creek
Dry Creek
Comal Creek
KRUEGAR
LANE
MISSOURI PACIFIC RAILROAD
MISSOURI KANSAS TEXAS RAILROAD
GUADALUPE COUNTY
482
81
35
water
RUD
MEC
CrD
MED
PuC
ErG
DeC3
KrB
KrA
Pt
ByA
ByB
KrB
Tn
HvD
HgD
LeA
HvB
AnB
Or
BrB
HeB
SuB
HoB
HeC3
AuC3
AgD3
AgC3
AuB
LeB
DeB
HeD3
int


100
N
(Joins sheet 95)
2 285 000 FEET
(Joins inset)
(Joins sheet 99)
670 000 FEET
660 000 FEET
2 265 000 FEET
Scale 1:20000
NEW BRAUNFELS
(county seat)
Solms
water
Comal Creek
Dry Creek
Four mile Creek
GUADALUPE
COUNTY
COUNTY LINE ROAD
MISSOURI KANSAS TEXAS RAIL ROAD
(Joins sheet 96)
2 291 000 FEET
(Joins upper right)
674 000 FEET
673 000 FEET
2 287 000 FEET


101
N
2 190 000 FEET
655 000 FEET
2 385 000 FEET
(Joins sheet 39)
(Joins sheet 97)
(Joins sheet 47)
(Joins sheet 102)
785 000 FEET
755 000 FEET
645 000 FEET
2 395 000 FEET
2 210 000 FEET
HvB
FeF4
Tn
HoB
HeC3
Brushy
Creek
HvD
ByA
HeD3
HoB
Tn
HoB
Tn
HvB
COUNTY
water
HeC3
HvD
HvB
HvD
HeD3
CALDWELL
HvD
HoB
Uhland
w
21
CrD
MEC
KrB
MED
DeB
KrC
TaB
Or
Cibolo
BEXAR
MED
LeB
ErG
LeA
SeB
LeB
LeA
GrC
LeB
COUNTY
Creek
GrC
MISSOURI PACIFIC RAILROAD
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

COMAL AND HAYS COUNTIES, TEXAS — SHEET NUMBER 102